Examining the Effect of Technology-Enhanced Formative Assessment on Student Engagement and Learning in Higher Education: An Action Research Study

Colin Cooney
BComm, MBS, MA
Maynooth University

A thesis submitted to Maynooth University, Department of Education, in fulfilment of the requirements for the Award of Doctor of Philosophy (PhD)

Date of Submission: February 2025

Maynooth University Department of Education
Head of Department: Dr Maija Salokangas
Supervisors:
Dr Rose Dolan
Dr Keith Young

Declaration

I have read and understood the Departmental policy on plagiarism and academic integrity.

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other tertiary education institution.

It is important to note that all research, reading, analysis, original ideas, and earlier drafts of the text are entirely my own. I acknowledge that I used an AI tool to assist with aspects of text revision. Specifically, I used ChatGPT (https://chatgpt.com) to help me think through alternative ways of expression in the Discussion and Conclusion chapters, with the aim of improving the flow and reducing repetition. All outputs generated by the AI were subsequently reviewed and further modified by me to align with my own tone and style of writing, and to ensure the accuracy and integrity of the original citations and arguments. No new text or content was generated by the AI. Its use was limited to improving sentence structure in specific paragraphs.

Information derived from the published or unpublished work of others has been acknowledged in the text, and a list of references has been provided.

Signature: 

Date: **14/2/25**

Table of Contents

Declaration ... ii
Table of Contents ... iii
List of Tables ... vi
List of Figures ... vii
Glossary of Acronyms ... ix
Glossary of Key Terms and Definitions ... x
Acknowledgements ... xii
Abstract ... xiii
Chapter 1: Introduction ... 1
1.1. Background to the Study ... 2
1.2. Problem Statement ... 5
1.3. Identifying the Gap in the Literature ... 7
1.4. Research Objectives and Questions ... 9
1.5. Overview of Methodology ... 10
1.6. Significance of the Study ... 11
1.7. Structure of the Thesis ... 12
Chapter 2: Literature Review ... 16
2.1. Exploring the Literature on Formative Assessment ... 17
2.1.1. The Conceptual Evolution of Formative Assessment ... 17
2.1.2. Advantages of Formative Assessment ... 22
2.1.3. Drawbacks in using Formative Assessment ... 29
2.2. Studies on the Impact of Feedback ... 32
2.2.1. Defining Feedback ... 32
2.2.2. Effective Feedback ... 37
2.2.3. Effective Feedback Challenges ... 40
2.3. The Use of Technology in Formative Assessment ... 42
2.3.1. Technology and Education Context ... 42
2.3.2. Benefits of Technology Enhanced Formative Assessment ... 44
2.3.3. Challenges with the Use of Technology in Assessment ... 51
2.3.4. Research Gaps in Technology Enhanced Learning ... 62
2.4. Gap in the Literature ... 66
Chapter 3: Theoretical Framework ... 68

3.1. Defining the Theoretical Framework **69**
3.2. Review of Key Theories and Models for this Study **70**
3.2.1. Learning-Oriented Assessment (LOA) 70
3.2.2. Technological Pedagogical Content Knowledge (TPACK) 77
3.3. Integrating the Theories and Models: Creating a Synthesised Framework **81**
Chapter 4: Research Methodology **88**
4.1. Overall Approach **89**
4.1.1. Assumptions in Action Research 92
4.2. Participatory Action Research **95**
4.2.1. Why Participatory Action Research? 95
4.2.2. Action Research Steps 105
4.3. Research Methods **110**
4.3.1. Research Location 111
4.3.2. Research Participants 112
4.3.3. Research Process and Timeline 114
4.3.4. Reconnaissance: Preliminary Expert Consultations 115
4.3.5. Data Gathering Instruments 116
4.4. Analysis of Data **126**
4.5. Ethical Considerations **130**
4.6. Conclusion **138**
Chapter 5: Findings **139**
5.1. Action Research Cycle 1 (ARC1) **139**
5.2. Action Research Cycle 2 (ARC2) **174**
5.3. Action Research Cycle 3 (ARC3) **203**
5.4. Summary of Key Findings **232**
Chapter 6: Discussion **235**
6.1. Interpretation of Findings: Alignment with the Theoretical Framework **235**
6.2. Discussion of Thematic Findings **238**
6.2.1. The Challenge of Student Engagement 238
6.2.2. Dynamics of Student Learning 250
6.2.3. Optimising Assessment Design 258
6.3. Conclusion **262**

Chapter 7: Conclusion **266**
7.1. Overview of Study **266**
7.2. Addressing the Research Questions and Key Themes in the Findings **267**
7.3. Significance of the Study **271**
7.4. Recommendations for Educational Practice **272**
7.5. Recommendations for Future Research **278**
7.5.1. Research Focused on Learners 279
7.5.2. Research Focused on Educators 280
7.5.3. Research Focused on Technology-Enhanced Formative Assessments 281
7.6. Recommendations for Policy **288**
7.6.1. Main Recommendations 288
7.6.2. Challenges and Strategic Considerations 291
7.6.3. Strategic Technology Adoption 291
7.7. Reflections on Professional Growth and Educational Change **292**
7.8. Concluding Remarks **296**
Bibliography **298**
Appendices **331**
Appendix A: Ethics Documentation **331**
Appendix B: Higher Education Institutions **344**
Appendix C: Summary of Action Research Cycles **345**
Appendix D: Surveys **346**
Appendix E: Quantitative and Qualitative Analysis **368**
Appendix F: TEFA/Intervention Materials **371**
Appendix G: Samples of Grading and Feedback **376**

List of Tables

Table 1. General Quiz Data [ARC1] (N=116) 148

Table 2. Correlation: Quiz Attempts, Attendance and Academic Performance [ARC1] (N=112) 153

Table 3. Quiz Development Time Invested [ARC1] 172

Table 4. General Quiz Data [ARC2] (N=116) 177

Table 5. Correlations: Quiz Attempts, Attendance and Academic Performance [ARC2] 182

Table 6. General Quiz Data [ARC3] (N=107) 212

Table 7. Correlations: Quiz Attempts, Attendance and Academic Performance [ARC3] 217

List of Figures

Figure 1: Framework for LOA (Carless, 2007) 72

Figure 2. Holistic Framework for LOA (Zeng et al., 2018) 74

Figure 3. TPACK Framework and its Knowledge Components (Koehler & Mishra, 2009) 78

Figure 4. Theoretical Framework for this Study (customised version of LOA with TPACK) 82

Figure 5. Action Research Cycle (Elliott, 1991) 106

Figure 6. Action Research Cycles (Coughlan and Coghlan, 2002) 108

Figure 7. Final Version of Action Research Cycle 109

Figure 8. Summary of Data Collection Methods 117

Figure 9. Quiz Characteristics [ARC1 Mid-Semester Survey] 141

Figure 10. Weekly VLE Engagement Analytics [ARC1] 144

Figure 11. Percentage of Active Moodle Users Completing Quizzes [ARC1] 145

Figure 12. Percentage of Active Moodle Users Engaging with Quizzes [ARC1] 146

Figure 13. Moodle Usage - Main v Comparison Group [ARC1] 147

Figure 14. Patterns and Flows of Quiz Attempts [ARC1] 149

Figure 15. Percentage of Completions per Quiz [ARC1] 150

Figure 16. Number of Quizzes Attempted per Student [ARC1] 150

Figure 17. Number of Attempts per Person across all Quizzes [ARC1] 151

Figure 18. Average Time per Quiz [ARC1] 151

Figure 19. Mean Quiz Grade [ARC1] 152

Figure 20. Attendance and Grades Relative to Quiz Attempts [ARC1] 154

Figure 21. Correlation: Attendance and Grades Relative to Quizzes Attempted [ARC1] 154

Figure 22. Reasons for Not Attempting a Quiz [ARC1 End of Semester Survey] 156

Figure 23. Quiz Characteristics (n=45) [ARC1 End of Semester Survey] 157

Figure 24. Perceived Effect of TEFAs on Exam Preparation, Engagement, and Grades [ARC1 End of Semester Survey] 159

Figure 25. Weekly VLE Engagement Analytics [ARC2] 175

Figure 26. Percentage of Active Moodle Users Completing Quizzes [ARC2]..... 176
Figure 27. Percentage of Active Moodle Users Engaging with Quizzes [ARC2]..... 177
Figure 28. Percentage of Completions per Quiz [ARC2] 178
Figure 29. Number of Attempts per Quiz [ARC2] 178
Figure 30. Completions per Quiz [ARC1 & ARC2 combined] 179
Figure 31. Number. of Attempts per Quiz [ARC1 & ARC2 combined] 180
Figure 32. Total Attempts per Quiz [ARC1 & ARC2 combined] 180
Figure 33. Quiz Characteristics (Moodle v Learnosity) [ARC2 End of Semester Survey] 183
Figure 34. Perceived Effect of TEFAs on Exam Preparation, Engagement, and Grades [ARC2 End of Semester Survey] 185
Figure 35. Quiz Characteristics (Moodle) [ARC3 Mid-Semester] 203
Figure 36. Weekly VLE Engagement Analytics [ARC3] 209
Figure 37. Percentage of Active Moodle Users Completing Quizzes [ARC3]..... 210
Figure 38. Percentage of Active Moodle Users Engaging with Quizzes [ARC3]..... 211
Figure 39. Number of Attempts per Quiz (ARC3) 213
Figure 40. Distribution of Total Quiz Attempts by Students 214
Figure 41. Participant Engagement and Attempt Patterns [ARC3] 215
Figure 42. Detailed Analysis of Quiz Attempts [ARC3] 216
Figure 43. Comparison of Quizzes with Attendance & Exam Performance [ARC3] 218
Figure 44. Quiz Characteristics (Moodle) [ARC3 End of Semester Survey] 220
Figure 45. Perceived Effect of TEFAs on Exam Preparation, Engagement, and Grades [ARC3 End of Semester Survey] 222
Figure 46 Pivot Table Analysis of Moodle VLE Data (ARC1)..... 368
Figure 47 Pivot Table Analysis of Moodle VLE Data (ARC1)..... 368
Figure 48 Quiz Answer Analysis – Low Scoring Questions Highlighted (ARC1) ... 370
Figure 49 Quiz Answer Analysis (ARC1) 370

Glossary of Acronyms

AaL:	Assessment as Learning
AfL:	Assessment for Learning
AoL:	Assessment of Learning
ARC:	Action Research Cycle
CAT:	Classroom Assessment Techniques
CBA:	Computer-Based Assessment
CELT:	Centre for Excellence in Learning and Teaching
CPD:	Continuing Professional Development
HE:	Higher Education
LOA:	Learning-Oriented Assessment
LMS:	Learning Management System
NFETL:	National Forum for the Enhancement of Teaching and Learning in Higher Education
PAR:	Participatory Action Research
SRL:	Self-Regulated Learning
TA:	Thematic Analysis
TEA:	Technology Enhanced Assessment
TEFA:	Technology Enhanced Formative Assessment
TEL:	Technology Enhanced Learning
TPACK:	Technological Pedagogical Content Knowledge
UEQ:	User Experience Questionnaire
VLE:	Virtual Learning Environment

Glossary of Key Terms and Definitions

Agency

The capacity of students to take ownership of their learning, make informed decisions, and act independently within the learning process. In this study, agency is linked to self-assessment, self-regulated learning, and the ability to navigate learning pathways with autonomy (Charteris & Thomas, 2017; Molloy et al., 2020).

Assessment as Learning (AaL)

A formative approach in which students actively engage in assessing their own learning through reflection, self-monitoring, and goal setting. AaL supports metacognitive development and learner autonomy, positioning assessment as an opportunity to deepen learning rather than simply measure it (Boud, 2000; Earl, 2003).

Assessment for Learning (AfL)

An approach to assessment that actively involves students in the learning process through goal setting, feedback, and reflection. While closely related to formative assessment, AfL is broader in scope, emphasising student agency, self-regulated learning, and metacognitive development. It positions assessment as a tool to support learning rather than simply measure it (Black & Wiliam, 1998b; Looney, 2019).

Formative Assessment

A continuous process during instruction that provides feedback to support student learning and inform teaching. It helps students identify areas for improvement and enables teachers to adjust their strategies based on student understanding. Unlike AaL, which centres on student-led reflection, formative assessment is typically teacher-initiated and focused on guiding learning in real time (Sadler, 1989; Wiliam & Thompson, 2008; CCSSO, 2018).

Learning

A dynamic and iterative process through which students acquire knowledge, skills, and understanding. In this study, learning is viewed as socially constructed and supported through feedback, reflection, and active engagement (Bruner, 1961; Vygotsky, 1978).

Learning Outcomes

Statements that define what students should know, understand, or be able to do by the end of a learning experience. Learning outcomes support not only certification but also

learning and development, aligning assessment with academic achievement, student engagement, and broader personal growth (Bloom et al.; Biggs, 1996).

Motivation (Extrinsic)

A form of motivation driven by external factors such as grades, deadlines, rewards, or recognition. Extrinsic motivation can influence how students approach learning tasks, often encouraging participation through structured incentives or performance expectations (Shepard et al., 2018).

Motivation (Intrinsic)

A form of motivation driven by internal factors such as curiosity, interest, or a desire for mastery. Intrinsic motivation supports deeper engagement and sustained learning, as students are motivated by the learning process itself rather than external rewards (Shepard et al., 2018).

Self-Assessment

The process by which students evaluate their own learning and performance using criteria, feedback, or self-generated standards. Self-assessment enhances feedback literacy and supports Assessment as Learning (AaL) by fostering autonomy and self-regulation (Boud, 1995; Andrade, 2019).

Self-Regulated Learning (SRL)

The ability of learners to plan, monitor, and evaluate their own learning processes. SRL involves setting goals, selecting strategies, and reflecting on outcomes, and is a key outcome supported by formative assessment and TEFAs (Zimmerman, 2002; Marín etal., 2020).

Student Engagement

The degree of attention, curiosity, and interest that students show in module content and in the learning process. Engagement is shaped by the design of learning activities, the quality of feedback, and the perceived relevance of assessments (Kahu, 2013; Major, 2015).

Technology-Enhanced Formative Assessments (TEFAs)

Digital tools and platforms used to deliver formative assessments that support learning through timely, personalised feedback. TEFAs are designed to enhance engagement, promote self-regulated learning, and provide insights for both students and educators (Gikandi et al., 2011; Blondeel et al., 2022).

Acknowledgements

This thesis would not have been possible without the unwavering support of a remarkable group of people.

First and foremost, to my wife Ann. Thank you for your patience, understanding, and steadfast support throughout this long journey. To my children, who grew up alongside this project, I look forward to spending more time with you all. My family provided a much-needed perspective beyond this academic world, and for that I am truly grateful.

Another big thanks to my parents for their constant encouragement and countless acts of kindness throughout this process. A special thanks to my cousin Gav, who, despite quite the busy schedule, never hesitated to offer his time and expertise, particularly during the crucial final stages (the nagging worked!!). I am incredibly grateful to Uncle Ivor and Auntie Tina for the use of their "shed" and the endless supply of tea, blue snacks, and most importantly, encouragement. Similarly, to my in-laws, Tom and Kay, for their hospitality, the use of their attic space, and the impromptu cooking lessons that became a regular fixture in my PhD days there. Thanks also to my good friends Hapo and Faulkner, neither of whom will thank me for mentioning them here, but both played their part in helping me through.

I am deeply indebted to my long-suffering Supervisor, Dr. Rose Dolan. Her guidance, insightful comments and discussions, endless patience, and a willingness to dedicate significant time to my work made this journey not only possible but also enriching. I am also incredibly thankful for the contributions of Dr. Keith Young, my second Supervisor, whose expertise and experience were invaluable in guiding me towards the completion of this project. I know he will be a big loss to MU and MIC's gain.

And finally, a special thanks goes out to my amazing students. This research would not have been possible without their participation and co-creation of the TEFAs. Their feedback shaped this project and inspired improvements in my teaching practice, both for them and for future cohorts. Their enthusiasm for learning has been the driving force behind this endeavour.

I sincerely appreciate the support of everyone who has been a part of this journey.

Abstract

This study investigated the role of technology-enhanced formative assessments (TEFAs) in fostering student engagement and improving learning outcomes in a higher education setting. In response to challenges I had encountered in my own teaching practice and with the growing need for more interactive and responsive pedagogical approaches, this research examined how digital tools can transform formative assessment to better support continuous learning. Positioned within an action research framework, this study explored TEFAs through three iterative cycles. Data collection involved a combination of quantitative and qualitative methods, including surveys, focus groups, learner analytics, and my own reflective observations as a lecturer. This diverse data set allowed for an in-depth analysis of the impact of TEFAs on student engagement, self-regulation, and academic performance within a higher education context, which was characterised by challenges like large class sizes, diverse student needs, and rigid assessment structures.

The findings revealed that the integration of digital tools into formative assessment practices can offer significant advantages. TEFAs facilitated timely, personalised feedback, which supports self-regulated learning. They also contribute to higher levels of student motivation and engagement by creating more interactive and relevant learning experiences. To guide the design and implementation of the TEFAs, this study developed a synthesised, integrated framework based on Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK) models. This framework offers a practical guide for educators looking to integrate TEFAs in higher education settings.

While the findings are context-specific, they offer valuable insights for broader educational practices. This research presents actionable recommendations for educators, instructional designers, and policymakers on how to effectively align technological and pedagogical objectives in the design of assessments. These recommendations contribute to wider discussions on the evolving role of formative assessment in higher education. It also suggests ways that institutions can adapt their assessment practices to better meet the needs of 21st-century learners. By connecting theoretical understanding with practical strategies, this study highlights the potential of TEFAs in creating more engaging and effective learning environments.

Chapter 1: Introduction

In today's rapidly evolving digital landscape, higher education is undergoing a profound transformation (Akinlolu et al., 2024). Traditional pedagogical approaches are being challenged by the expectations of a new generation of learners who are looking for more flexible, interactive, and personalised learning experiences (Gaebel et al., 2021). There is growing recognition that assessment plays an important role, not only in evaluating learning, but also in shaping our understanding of what constitutes effective learning. Institutions and educators are actively adapting to these changes. However, while technology has transformed many aspects of higher education, assessment practices, particularly formative assessment, often lag behind and remain misaligned with the needs of the digital age (Bearman et al., 2023).

In light of these ongoing pedological developments, this study addressed the question of whether TEFAs can be designed and implemented to significantly enhance student engagement, while furthering the students' achievement of learning outcomes in higher education. While previous studies in higher education have explored the benefits of technology integration in teaching and the advantages of formative assessment as a pedagogical tool, the review of the literature presented in Chapter 2 revealed that few studies have examined the intersection of these domains in a real-world context. Those earlier studies showed that this gap in the research is particularly pronounced in higher education settings, where large class sizes, diverse student needs, and rigid assessment structures present unique challenges.

The relevance of this study was reinforced by the increasing demand for educational models that are responsive to the changing needs of 21st century learners (van Laar et al., 2020). Today's students require learning experiences that are flexible, provide continuous feedback, and foster self-regulated learning (Broadbent, 2021). As educational institutions continue to embed digital tools into their curricula, understanding the impact of these tools on student engagement and learning becomes critical for both educators and policymakers. The ETS Report (2024) emphasises that the future of assessments will increasingly depend on adaptive, technology-driven approaches that personalise learning and provide timely, actionable feedback. Understanding the impact of these tools on student engagement and learning is therefore critical for both educators and policymakers (Kyllonen & Sevak, 2024).

By investigating the role of TEFAs in higher education, this study aimed to contribute to both the academic discourse on educational innovation and the practical design of assessment strategies that can be applied across diverse educational settings. Specifically, the study used an action research methodology to explore how digital tools can be leveraged to create assessments that are not only pedagogically sound, but also engaging and relevant to the learner. This approach offered a clearer understanding of the relationship between content, pedagogy, and technology, offering insights that can inform the future of teaching and learning in higher education.

This chapter begins by providing a Background to the Study. It continues by outlining the Problem statement, followed by an identification of the gap in the literature, an explanation of the Research Objectives and Questions, and an Overview of the Methodology. The chapter concludes with a discussion of the Significance of the Study and an overview of the Structure of the Thesis.

1.1. Background to the Study

The integration of Educational Technology (EdTech) in Irish education has undergone significant changes over the past few decades, shaping practices in both primary and post-primary education and, increasingly, in higher education (INTO, 2016). While the roots of EdTech in Ireland can be traced back to the 1980s with initiatives like the Computers in Education project (1984-1986), it was the Schools IT 2000 programme, launched in 1997, that marked a major shift towards digital integration in education. This programme aimed to build digital literacy among students and enhance teachers' ICT capabilities, but its impact varied due to inconsistencies in infrastructure and support across schools (DES, 2008).

In the early 2000s, EdTech developments in Ireland remained focused on primary and secondary education, with policies such as Investing Effectively in ICT in Schools 2008-2013 and the Digital Strategy for Schools 2015-2020. These initiatives aimed to embed ICT across the curriculum, providing broader access to digital tools and fostering a culture of digital learning. However, uptake varied due to challenges like inadequate professional development, limited resources, and inconsistent teacher readiness (McGarr, 2009). Early responses to technology-based assessments were mixed, with some educators concerned about increased workload and the potential disruption to traditional teaching methods (DES, 2008).

While the primary and secondary sectors have benefitted from substantial research and the development of policies that focus on EdTech integration, the higher education sector historically received less attention. The adoption of digital tools in higher education has been slower, compounded by the diverse nature of institutions and early resistance from academics to technology-driven changes. Much of the initial emphasis in higher education was on building digital capacity, with frameworks like the National Strategy for Higher Education to 2030 (DES, 2011) and the work of the High-Level Group on the Modernisation of Higher Education (McAleese and Vassiliou, 2014). These initiatives emphasised the importance of technology-enhanced learning (TEL) and the strategic integration of digital tools into teaching and assessment practices. However, as the literature review in Chapter 2:Literature Review shows, compared to the second-level sector, research on effectively leveraging these tools for formative assessment in higher education have remained underdeveloped.

Before I began this research, I believed that, while many professions have undergone radical transformation, the teaching profession has largely remained unchanged. It has been suggested that while a surgeon from a century ago would be lost in a modern operating theatre, a lecturer from the same era could easily step into today's lecture theatre. However, this perspective is overly simplistic in the first instance, as it as it conflates basic technological enhancements, such as the use of data projectors and PowerPoint, with the deeper integration of technology into pedagogy. It also ignores the subtle yet significant changes that have occurred in pedagogical approaches over time. Watters (2019) argued that educational technologies have continually evolved in response to broader societal challenges, leading to a more pertinent question: not whether education has changed, but how exactly it changed and to what ends? Selwyn (2008) stated that while technology has dramatically transformed other sectors, educational institutions often adopt new practices more cautiously, reflecting deep-seated resistance to change. He and his colleagues argued that this resistance is particularly evident in higher education, where the integration of technology has been marked by a slow and careful approach to perceived risks and the prevalence of entrenched practices (Selwyn et al., 2021).

As my research developed, I began to see that higher education had indeed undergone significant transformations, although in ways that were not always immediately visible. The High-Level Group on the Modernisation of Higher Education (McAleese &

Vassiliou, 2014) emphasised that while traditional lecture-based teaching remains central, it was increasingly being complemented by digital tools and new pedagogical approaches. These shifts suggested that effective technology integration is not merely an add-on but a strategic priority that should be embedded within institutional efforts to enhance learning outcomes and adapt to the evolving educational landscape (NFETL, 2014).

The field of TEL has gained significant attention in in the 21st century due to its potential to reshape educational practices. Traditional assessment methods, dominated by summative approaches, have been widely criticised for their limited ability to support ongoing learning and foster student engagement (Landl and Wylie, 2024). Student engagement in this context refers to learners' active participation and emotional and cognitive investment in their educational activities, shaped by personal motivations as well as the learning environment (Kahu, 2013; Major, 2015). In contrast to summative methods, formative assessments are recognised for their capacity to provide continuous feedback, support self-regulation, and cultivate a deeper understanding of subject matter (Morris, et al., 2021). The growing emphasis on TEFAs aligns with global trends towards personalised learning and continuous feedback loops, explicitly aiming to enhance student engagement and promote more meaningful interactions between learners and their learning environments.

Since 2020, there has been a growing recognition of the importance of EdTech in higher education, driven in part by the shift to digital and blended learning environments during the COVID-19 pandemic (Slade et al., 2022). The increasing adoption by HEIs of Virtual Learning Environments (VLEs) like Moodle and Blackboard, has provided new opportunities for integrating formative assessments that offer continuous feedback, support self-regulated learning, and enhance student engagement.

In the context of this research, self-regulation is understood as students' ability to manage their own learning by setting goals, monitoring their progress, and adapting strategies based on feedback (Zimmerman, 2002; Broadbent et al., 2021). Student agency, closely related to self-regulation, involves learners taking an active and autonomous role in their educational processes, making meaningful decisions about their learning and assessment practices (Charteris and Thomas, 2017; Molloy et al., 2020). Effective integration of these digital tools thus requires educators not only to reconsider traditional assessment practices but also to foster an environment that

actively promotes self-regulation and student agency. This involves supporting students in developing the skills needed to engage thoughtfully and independently with formative assessments (UNESCO, 2023).

In parallel with the shift towards digital formative assessment, there has also been a growing interest in Assessment as Learning (AaL), a concept that positions the student as an active agent in the learning and assessment process. Rather than simply receiving feedback, students are encouraged to reflect, self-monitor, and set goals based on formative information (Boud, 2000; Earl, 2003). This orientation towards metacognitive development and learner autonomy is explored further in the Theoretical Framework (Chapter 3).

1.2. Problem Statement

In the evolving landscape of higher education, the integration of technology into teaching and learning practices has become increasingly prevalent, offering new opportunities for enhancing educational outcomes (McAleese & Vassiliou, 2014; NFETL, 2015). However, this integration also presents significant challenges, particularly in the domain of assessment. Traditional assessment methods, often focused on summative evaluation, have been criticised for their inability to fully capture the nuances of student learning and engagement (Gaebel et al., 2021; Zhang, 2022). While formative assessments are recognised for their potential to support continuous learning and provide timely feedback, the effective incorporation of digital tools into these assessments remains underexplored (UNESCO, 2023).

Reflecting on my experience as a lecturer and informed by my reading in this area, the challenges driving this research can be encapsulated in what I term the “four Ls”: Lack of engagement, Large classes, Lack of understanding of learners’ knowledge during the semester, and Lack of individual autonomy. These interrelated challenges illustrate persistent barriers in effectively engaging students, understanding their learning needs, and adapting teaching approaches in large and rigidly structured educational settings.

The first problem I encountered was the lack of engagement among my students, particularly in subjects that I teach like Management Information Systems and Technology and Information Management. Despite the critical importance of these topics, they often seemed abstract and irrelevant to students, resulting in low levels of interest. This disengagement was evident in students’ feedback, which consistently labelled the content as “dull”. It was further corroborated by their low participation

metrics on Moodle, the VLE used in my HEI. The difficulty in making these complex and theoretical subjects more engaging is indicative of the problem that results when assessments do not engage students. As Bennett et al. (2017) pointed out, engagement is often a challenge in large classes and in subjects perceived as theoretical.

The second challenge stemmed from the consistently large class sizes I faced, with lecture cohorts averaging around 120 students. Although not huge in the university sector in Ireland, this would be among the largest classes in our institution. In such settings, assessment methods often struggled to be both effective and equitable. Establishing individual connections with students during bi-weekly sessions was nearly impossible, making it difficult to determine whether students had met the learning outcomes until the end-of-semester assessments. This disconnect between teaching and understanding students' progress highlighted the need for formative assessments that provide real-time insights into students' comprehension.

The third problem is that it is often not possible to assess learners' knowledge during the semester. When the primary reliance is on one final end-of-semester examination, there may be a significant gap in identifying how well students are understanding the content as a course progresses. Without continuous assessment opportunities, any interventions to support struggling students often come too late. The absence of ongoing checkpoints may prevent the timely identification and resolution of learning challenges, reducing the overall effectiveness of teaching and learning.

The fourth challenge is related to the lack of individual autonomy in structuring the module. Despite recognising the potential of formative assessment in enhancing both student and lecturer autonomy, professional accreditation requirements often constrain the ability to adjust content or assessment methods. For example, the demands of leading accountancy bodies, and other certifying organisations, often require a substantial end-of-semester exam, restricting the flexibility to incorporate more formative assessment strategies. This lack of autonomy is a common issue in programmes tied to professional certifications, where rigid structures often limit the potential for innovative assessment approaches.

Beyond these main challenges, broader systemic issues also became evident, such as the entrenched culture of summative assessment that dominates both secondary and higher education (Black and Wiliam, 1998a; Sadler, 1998). This culture is heavily shaped by the high-stakes Leaving Certificate in Ireland, a national final examination

taken by secondary school students first introduced in 1924 (Coolahan et al., 2017). The results of this exam determine entry to third-level courses, arguably prioritising results over learning and making it challenging to position formative assessment as a valuable counterpart to summative practices (Smyth & Banks, 2012). Coolahan et al. (2017) also describe how the high-stakes nature of the Leaving Certificate shapes both teaching and learning practices, as it rewards specific exam-focused skills over broader, higher-order learning outcomes. Consequently, it leads to a strong exam-oriented culture, where the emphasis often remains on knowledge recall. The Leaving Certificate system (DES, 2004) itself has roots in the civil service exams that were used to select public servants in the 19th century, a model that has remained largely unchanged despite significant advancements in pedagogy and technology. The focus on a final exam, much like the traditional civil service assessments, reflects a dated approach that no longer aligns with the demands of modern education, particularly given the potential for continuous assessment enabled by digital tools. In the context of higher education, this reliance on final examinations now feels similarly outdated, as formative assessment practices can better support student learning, providing opportunities for ongoing feedback, engagement, and self-regulation through technology.

These problems in the teaching and learning environment, which I observed in my own practice, became the catalyst for the research that underpinned my study. The next step was to interrogate the literature to discover what other scholarly studies had been conducted in this field, and to verify that there was a gap in the literature that could provide a rationale for my own research.

1.3. Identifying the Gap in the Literature

Despite a growing body of research on TEL and formative assessment, McCallum and Milner (2021) identified that there was a critical gap in understanding how these two areas intersect in higher education settings on a practical level. A review of the literature at the beginning of my study, as will be shown in Chapter 2: Literature Review, focused on either the benefits of technology integration or the advantages of formative assessment, but studies rarely explored how specific technological tools that are integrated into formative assessment strategies impact student engagement and learning outcomes in real-world educational environments (NFETL, 2017). A key example of this, as revealed by the literature review, was the lack of research examining how technology can be applied practically to improve formative assessment practices in

ways that resonate with students and educators alike (Looney, 2019). While there was a general consensus regarding the importance of formative assessments in promoting continuous learning and feedback, there was limited empirical evidence concerning how these assessments could be effectively enhanced with digital tools to achieve meaningful educational outcomes (Kiersey et al., 2018). Additionally, most previous studies had approached the topic either from a purely technical or pedagogical standpoint. This binary approach often neglected the need for a holistic understanding of how content, pedagogy, and technology intersect in designing assessments that are practical, scalable, and impactful (Koehler et al., 2013).

Although some studies had examined the influence of TEFAs on student engagement and learning, their scope was frequently limited to controlled environments. Consequently, our understanding remains incomplete. Specifically, we need to know more about how these tools operate within diverse institutional settings and student demographics (Kiersey, Devitt and Brady, 2018; Zhang, 2022; UNESCO, 2023). These knowledge gaps are particularly evident in higher education, where the adoption of technology-enhanced assessments has been inconsistent, and where there is a need for scalable, evidence-based approaches to address the challenges related to engagement and learning.

This research explored the way in which TEFAs can positively influence engagement and learning outcomes, however, it explicitly rejects a simplistic view of educational technology as an inherently beneficial or inevitable solution. Educational technologies are deeply embedded within ideological, economic, and political contexts, and their use can reinforce, rather than challenge, existing inequalities and educational commodification (Selwyn, 2015; Watters, 2019). Therefore, the adoption of technology within this study is approached critically and reflectively, acknowledging both its potential benefits and its underlying challenges. A deeper engagement with these critical issues is presented in Section 2.3.3 of the Literature Review, highlighting broader critiques of techno-positivity and the marketisation of higher education.

This research sought to address these gaps by examining how TEFAs affect student engagement and learning outcomes within a real-world higher education environment. By focusing on the practical application of these tools and the challenges associated with their use, the study aimed to generate actionable insights for educators seeking to effectively integrate digital tools into their assessment practices across diverse

educational settings. The ultimate goal was to contribute to a deeper understanding of the practical integration of technology within formative assessment, shifting the focus from theoretical discussions to concrete, actionable strategies that can improve both teaching and learning in higher education.

1.4. Research Objectives and Questions

While the overarching goal of this study was to explore the effects of TEFAs on student engagement and learning outcomes, the research questions evolved inductively over the cycles of action research. This iterative development of questions allowed for a deeper exploration of both the breadth and depth of these effects within a higher education context. As insights emerged and new patterns were observed, additional questions were identified, reflecting a responsive and adaptive research approach. The following questions, refined through each cycle, became essential in directing the research:

1. *How do technology-enhanced formative assessments influence student engagement in a higher education setting?*

This question aimed to identify the specific aspects of student engagement that are most significantly affected by the integration of technology in formative assessments.

2. *What are the effects of technology-enhanced formative assessments on the learning outcomes of a selected population of students?*

Focusing on educational outcomes, this question explored whether the use of technology in formative assessments leads to improved learning achievements, such as better understanding and retention of course, as well as improved academic performance.

3. *How do the students participating in the study perceive the impact of technology-enhanced formative assessments on their learning processes?*

This question sought to capture the students' perspectives and attitudes towards the use of technology in their assessments. It aimed to gauge student satisfaction, perceived usefulness, and the potential motivational effects of such assessments.

4. *What challenges do educators face when implementing technology-enhanced formative assessments, and how can these challenges be mitigated?*

This question explored the practical implications for teaching staff and the hurdles educators face when adopting and implementing technology-enhanced assessments. It also sought to identify effective strategies to address these challenges.

These questions directed the empirical investigation and ensured alignment with both theoretical and practical considerations.

1.5. Overview of Methodology

This study adopted an action research approach, characterised by iterative cycles of planning, action, observation, and reflection. Action research was chosen due to its suitability for educational settings, where continuous improvement and responsive adaptation are essential. As Somekh (1994) noted, action research grounds knowledge in the context of practice, making it an appropriate method for exploring the interplay between technology-enhanced formative assessment and student engagement. Scholars such as Elliott (1998) and Coghlan (2014) have defined action research as a framework enabling practitioners to work within their specific contexts, using their knowledge and expertise to implement change and evaluate its effects. Elliott's version of action research emphasises the iterative nature of the process, with cycles of inquiry facilitating reflection and adaptation at each stage. Similarly, Coghlan highlighted the significance of insider action research, where the researcher is embedded within the environment, allowing for critical reflection on their dual role as practitioner and researcher.

Jean McNiff's (2002) contributions to action research are also relevant for this study, particularly her focus on collaborative inquiry and reflective practice. The co-construction of formative assessments with learners in this study reflected McNiff's (2002) model, where the researcher actively involves their participants. This action research was more aligned with these scholars' perspectives than with the work of Jack Whitehead's (Whitehead & McNiff, 2006; Whitehead, 2016; Whitehead et al., 2020), which centres on living educational theories. This study's emphasis was on systematic cycles of improvement rather than the development of personal theories of change, as seen in Whitehead's Living Educational Theory.

The methodology of this current study integrated both qualitative and quantitative data collection and analysis techniques. Data were gathered through surveys, focus groups, learner analytics from the Virtual Learning Environment (VLE), and reflective journals. This combination of methods aimed to provide a comprehensive understanding of the

impact of the interventions, in line with recommendations by Cohen et al. (2018). The iterative design also allowed for the incorporation of student feedback at various points, ensuring the co-construction of formative assessments with the learners, consistent with the principles of participatory action research.

Ethical considerations were essential throughout the research. Recognising my dual role as both a lecturer and researcher, several measures were implemented to mitigate potential power imbalances and maintain the study's integrity. Participation was entirely voluntary, with informed consent obtained from all participants. Confidentiality and anonymity were safeguarded by using pseudonyms and secure data storage. Additionally, participants were assured that their academic performance would not be influenced by their involvement in the study, minimising any pressure to take part. These methodological matters are discussed in further detail in Chapter 4: Research Methodology.

1.6. Significance of the Study

Although this study was situated within the specific context of my own development as an educator and the institutional setting in which it was conducted, it was expected that the findings would offer actionable insights with practical implications for a wider audience. The research was not designed to be broadly generalisable, rather, it aimed to provide a reflective, context-specific analysis of the implementation of TEFAs in higher education.

The insights gained from this setting are intended to help inform similar practices in comparable educational contexts, offering educators, instructional designers, policymakers, and other stakeholders valuable strategies to consider. For educators, the study aims to offer evidence-based strategies for incorporating digital tools into formative assessments in ways that are pedagogically sound and aligned with broader learning objectives. The practical recommendations derived from the research are expected to help educators enhance student engagement, provide timely and personalised feedback, and support the development of critical thinking and self-regulated learning skills. It is hoped that these strategies will prove particularly relevant in the context of increasingly digital and hybrid learning environments, where the effective use of technology is essential for maintaining educational quality.

For instructional designers and curriculum developers, the integrated Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge

(TPACK) framework that I developed for this study, aims to establish a valuable blueprint for creating assessments that are both innovative and educationally effective. The research findings highlight the importance of aligning technological tools with pedagogical goals and offer guidance on how to achieve this alignment in practice. This has the potential to lead to the development of more sophisticated and effective assessment systems that better meet the needs of 21st century learners.

For policymakers and institutional leaders, the study's findings could prove particularly beneficial when it comes to understanding the broader implications of technology-enhanced assessment practices for educational policy and strategy. The recommendations based on the research findings highlight the need for policies that support the integration of formative assessments with digital tools, including investment in professional development for educators and the provision of appropriate technological infrastructure. By adopting these recommendations, institutions may be able to enhance their capacity to deliver high-quality education that is both inclusive and adaptive to the changing needs of students.

1.7. Structure of the Thesis

This introductory chapter has provided an overview of the research focus, contextual background, and the key questions that guide this study. The following outlines the structure of the remaining chapters.

Chapter 2: Literature Review

This chapter examines the existing research and theoretical foundations relevant to TEFAs in higher education. It begins by tracing the evolution from traditional summative assessments to formative approaches that prioritise continuous feedback, student engagement, and self-regulated learning. The chapter then analyses studies advocating for the integration of digital technologies, evaluating how technology can be effectively combined with pedagogical strategies. It reviews empirical studies on the impact of TEFAs on student engagement and learning outcomes, highlighting both the benefits and challenges of using digital tools in assessment. Additionally, the chapter considers the wider implications of integrating technology with assessment, including the role of continuous feedback and the balance between formative and summative assessments. By identifying gaps in the current literature, this review establishes the theoretical and practical foundation for the research, informing the development of the study's theoretical framework and methodology.

Chapter 3: Theoretical Framework

Chapter 3 outlines the key theories and models underpinning the study, providing the theoretical foundation for the research. Central to this framework are two main theories: Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK). The chapter begins by defining the LOA framework, which focuses on the dual role of assessment in both evaluating and educating students. LOA is examined in detail, particularly its emphasis on formative assessment, feedback, and student-centred learning. These are all essential to understanding the impact of technology-enhanced assessments. The chapter then explores the TPACK framework, which integrates technology with pedagogical strategies and content knowledge. TPACK is discussed as a model offering a comprehensive approach to designing and delivering content in educational settings, especially those enhanced by digital tools. The framework's relevance to the study lies in its provision of a scholarly rationale for the meaningful integration of technology into formative assessment practices. The chapter then presents an integrated theoretical model combining LOA and TPACK, tailored for this research. This customised framework addresses the research problem by guiding the design, implementation, and analysis of TEFAs. Overall, this framework establishes the study's theoretical foundation, explaining how these key models are used to explore the relationship between technology, pedagogy, and assessment in higher education.

Chapter 4: Research Methodology

Chapter 4: Research Methodology describes the methodology used in this study. It details the approach, methods, and design used to conduct the research, ensuring a rigorous and systematic investigation of the research problem. It begins by outlining the research approach, which was grounded in action research. This approach was chosen for its iterative nature, enabling continuous reflection and adaptation throughout the study. The chapter then describes the research design, combining both qualitative and quantitative methods to provide a comprehensive analysis of the impact of TEFAs. Key data collection methods include surveys, interviews, and Learning Management System (LMS) data analytics, each selected to capture different aspects of student engagement and learning outcomes. The methodology section also discusses the sampling strategy, detailing participant selection, and how the study ensured diversity and relevance in its sample. The chapter explains the data analysis techniques used, including thematic

analysis for qualitative data and statistical analysis for quantitative data, ensuring robust and valid findings. The chapter concludes with a detailed account of the study's ethical considerations, such as informed consent, data confidentiality, and minimising potential risks to participants. These considerations are integrated throughout the research design to uphold the study's integrity and ethical standards.

Chapter 5: Results

This chapter presents the key research findings, based on the analysis of data collected through various methods. The results for each of the three action research cycles are presented separately to maintain clarity and structure. This approach reflects the cyclical nature of the action research process, where data collection and analysis were conducted iteratively within each cycle, allowing for reflection and adaptation before proceeding to the next. These findings are then synthesised to highlight overarching patterns and trends across the cycles.

The chapter begins by outlining the outcomes of the quantitative analysis, including statistical results that demonstrate the impact of TEFAs on student engagement and learning outcomes. This includes measures of student participation, performance, and feedback interactions, with comparisons made across different groups and assessment types. Each cycle's quantitative data is examined in detail. I then present the qualitative findings, which offer insights derived from focus groups and thematic analyses of student and educator feedback. These findings describe students' experiences with TEFAs, including their reflections on motivation, engagement, and self-regulated learning. The chapter also identifies patterns and themes that emerged from the data, such as the role of continuous feedback, the effectiveness of specific digital tools, and the challenges students encountered when interacting with these assessments. My own observations on the practicalities and challenges of implementing TEFAs are also included, further enriching the dataset.

The chapter concludes by synthesising the findings, identifying patterns and themes that emerged from the data. These include the role of continuous feedback, the perceived effectiveness of specific digital tools, and challenges faced by students when interacting with TEFAs. By structuring the findings to address the research questions and hypotheses directly, this chapter establishes a foundation for the interpretive and contextual discussion in Chapter 6.

Chapter 6: Discussion

The chapter begins by revisiting the LOA and TPACK frameworks, alongside the customised LOA-TPACK framework developed for this study. It examines how these theoretical underpinnings guided the research and interprets how the customised framework itself evolved in response to the findings. The chapter then explores the implications of the key findings, particularly the role of TEFAs in influencing student engagement and learning outcomes. This discussion emphasises how continuous feedback, as facilitated by digital tools, plays a crucial role in supporting self-regulated learning and enhancing overall educational experiences. The discussion also addresses the challenges identified in this research, such as balancing formative and summative assessments and the practical difficulties encountered in implementing technology-enhanced assessments. These challenges are discussed within the wider educational context, providing insights into how they can be addressed in practice.

Chapter 7: Conclusion

The concluding chapter synthesises the research findings and reflects on the study's overall significance. It begins by revisiting the primary research questions, highlighting how the study has addressed these questions and the key themes that emerged. The chapter then explores the implications for educational practice, offering actionable recommendations for educators, policymakers, and institutions on integrating TEFAs in higher education. Additionally, it identifies opportunities for future research and discusses the need for sustained professional development and ongoing infrastructural support. The chapter concludes with final reflections, emphasising the transformative potential of digital tools in creating more engaging, effective, and inclusive learning environments, while acknowledging the ongoing challenges and considerations in balancing pedagogy and technological innovation.

Chapter 2: Literature Review

This chapter reviews the extant literature that is relevant to this study of the impact of technology-enhanced formative assessments (TEFAs) on student engagement. The chapter first explores the broader literature on formative assessment, examining its theoretical underpinnings and the role it plays in enhancing learning. This is followed by a critical review of studies that have focused on feedback, particularly how formative feedback influences student learning and engagement. The subsequent section examines the literature on the integration of technology into formative assessment, focusing on its potential to enhance the assessment process and student learning experiences. Finally, the chapter identifies the gaps in current research, highlighting areas where further investigation is needed and outlining the specific focus of this study within the broader academic discourse.

Literature Search and Selection Methodology

The literature review was conducted through an iterative and exploratory process, designed to remain flexible and adaptive. The initial searches were performed across well-established academic databases, including Academic Search Complete, ERIC, JSTOR, ProQuest, ScienceDirect, Scopus, and Web of Science. Over time, the increased functionality of institutional search tools, including MultiSearch and LibrarySearch in my home institution and at Maynooth University, allowed for more streamlined and comprehensive searches across a wide range of academic resources. Additionally, Google Scholar was employed in later stages as a cross-check, to ensure coverage of less accessible literature and to verify the inclusion of the most up-to-date studies.

Keywords relevant to the research focus, such as ‘assessment’, ‘formative assessment’, ‘EdTech’, ‘assessment for learning’, and ‘higher education’, were used to guide the search process. After an initial review of titles and abstracts to determine relevance, a more in-depth engagement was undertaken with those studies that closely aligned with the research objectives. To broaden the scope, a snowballing technique was used, where references from key articles were followed to discover foundational theories and influential works. Input from academic colleagues, along with the use of digital tools

like Connected Papers[1] and Research Rabbit[2], helped to identify highly cited research and interconnected studies.

Although no strict timeframe was imposed on the selection of literature, priority was given to sources that provided valuable insights into historical and current perspectives on the areas of formative assessment, feedback, and the role of technology in education. The iterative nature of action research allowed for the integration of newly published sources, as well as older, but newly discovered literature. These sources were selected based on their relevance to findings from specific cycles of the study, ensuring the review remained both up-to-date and reflective of key developments throughout the research process. This adaptive approach ensured that the literature review captured a broad range of perspectives and contexts, contributing to a comprehensive understanding of the study's aims.

2.1. Exploring the Literature on Formative Assessment

This section examines how definitions and understandings of formative assessment have developed over time, providing an overview to set the foundation for later analysis.

2.1.1. The Conceptual Evolution of Formative Assessment

In a bid to establish a contemporary understanding of formative assessment, Bennett (2011, p. 6) posed the question: "What, exactly, is 'formative assessment'?" To answer this question, he drew on Scriven (1966), who first proposed a division between summative and formative functions in relation to programme evaluation. From Scriven's perspective, summative evaluation supplied the necessary data to appraise the overall effectiveness of an educational programme, while formative evaluation focused on facilitating the programme's enhancement. The next milestone in this evolution was reached when this concept was transferred from programmes to students by Bloom et al. (1971), who echoed Scriven's terms. He argued that the goal of formative evaluation was to offer continuous feedback and adjustments throughout the teaching-learning cycle, whereas summative evaluation was used to assess the learners' overall accomplishments at the completion of a course or programme. The subsequent efforts to refine and expand this distinction have largely focused on deepening the conceptualisation of formative assessment as an integrated process rather than a single

[1] https://www.connectedpapers.com
[2] https://researchrabbitapp.com

event. In Australia, scholars like Sadler (1989) advanced formative assessment by emphasising the critical role of feedback loops and student self-regulation in learning. Meanwhile, in the UK, the Assessment Reform Group (1999) promoted a broader understanding of formative assessment as an inherently student-centred process, highlighting its capacity to engage students in their learning journey through active involvement and reflective practices.

Shepard (2008) identified a divide in how formative assessment is perceived, pointing out that some scholars view it as a tool or instrument, such as a diagnostic or interim test, or a database, from which teachers can create such tests. Others, however, see formative assessment as a process that offers qualitative insights into student understanding rather than simply generating a score. This process-oriented perspective highlights the importance of using assessment results to adjust teaching strategies to meet students' needs (Wiliam & Thompson, 2008), often within short instructional cycles.

In more recent years, Wylie and Lyon (2016) based their definition of formative assessment on three key elements. First, they emphasised that formative assessment is an ongoing process, distinct from summative assessments, which are typically confined to the end of a learning period. Secondly, in relation to the timing and scope of formative assessment, noted that the term "during instruction" (p. 9) is pivotal in this context. It implies that formative assessment occurs, not only within individual class sessions, but also throughout broader instructional sequences that may extend over several weeks. Finally, Wylie and Lyon stressed that formative assessment is a collaborative endeavour involving both students and teachers. They posited that, unlike more traditional assessment models, formative assessment is not merely a tool for educators; students are active participants in both gathering and interpreting learning evidence. Much like Bennett, however, Wylie and Lyon were not operating in a critical vaccum. These three elements align with earlier, broader perspectives in the literature while also offering more refined insights. For example, Black and Wiliam (1998a) similarly described formative assessment as an iterative process that informs teaching and learning decisions, emphasising the active role of students in the assessment process. Moreover, while Bloom et al.'s (1971) original definition focused primarily on formative assessment as a diagnostic tool for teachers, Nicol and MacFarlane-Dick's (2006) more constructivist approach argues that formative assessment empowers students through

self-regulation and reflection. Conversely, Bennett (2011) argued that each of the viewpoints mentioned above may be oversimplifying the concept. He maintained that defining formative assessment solely as an instrument ignores the fact that even the most meticulously designed, empirically backed tool may not have instructional effectiveness if the procedure surrounding its application is flawed.

Returning to the foundational work Black and Wiliam (1998b, 2009) understanding of formative assessment as a collaborative and iterative process that informs teaching and learning decisions has been very significant in informing this current study. It is therefore worth considering some critiques of their position in a little more detail. While acknowledging that Black and Wiliam are considered to be among the leading experts in the field of formative assessment, Bennett (2011) suggested that policies at that time treated the classroom as a black box, with inputs from the outside being fed into it and outputs expected without studying what happens inside.

Returning to the foundational work of Black and Wiliam (1998b, 2009) helps show the development of these ideas and underlines their ongoing relevance to this current study. Black and Wiliam's conceptualisation of formative assessment similarly highlights a collaborative, iterative process that informs teaching and learning decisions. While acknowledging that Black and Wiliam are considered to be among the leading experts in the field of formative assessment, Bennett (2011) suggested that policies at that time treated the classroom as a black box, with inputs from the outside being fed into it and outputs expected without studying what happens inside. Early on, Black and Wiliam (1998a, p. 7) defined formative assessment as "encompassing all those activities undertaken by teachers, and/or their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged." Later, Wiliam (2011) acknowledged that while multiple definitions exist, no single formulation can fully capture the scope of formative assessment or its place within broader educational theories. Meanwhile, the Assessment Reform Group (2002), in which Black and Wiliam were key members, reinforced this stance, describing formative assessment as a practice that uses evidence about student achievement to inform real-time decisions by teachers, learners, or peers. In this sense, these various definitions both reflect and extend each other, increasingly foregrounding the evidence-driven, interactive relationship between teaching practices and student learning.

In 2018, the US Council of Chief State School Officers (CCSSO and FAST, 2018) reinforced the position held by Black and William by offering the following definition:

> a planned, ongoing process used by all students and teachers during learning and teaching to elicit and use evidence of student learning to improve student understanding of intended disciplinary learning outcomes and support students to become self-directed learners. (CCSSO, 2018, p. 2)

This definition, revised from an earlier 2006 version (CCSSO, 2008) frames formative assessment as an intentional and ongoing process, actively involving both students and teachers throughout all the learning and teaching phases. The updates place greater emphasis on systematic planning, a wider focus on both learning and teaching, and the need to adapt formative assessment to various disciplinary contexts. Furthermore, the updated definition stresses the importance of clear learning objectives, continuous feedback loops, and the incorporation of self-assessment and goal setting by students. It also highlights the collaborative essence of formative assessment and the imperative for continual professional development and learning for teachers. The revised CCSSO definition aligns with earlier perspectives by Black and Wiliam (1998b, 2009), but also provides a structured, practical framework for embedding formative assessment within everyday instructional practice.

According to the latest perspectives, formative assessment is increasingly seen as a flexible and integrative approach that includes real-time feedback, goal-setting, and collaborative learning practices (Chen, Jiao & Hu, 2021; Morris et al., 2021). For example, Broadbent et al. (2021) noted that formative assessment, when applied in technology-enhanced environments, requires careful alignment with learning objectives and continuous adaptation based on student engagement and feedback. This approach emphasises that formative assessment is not a static concept but a dynamic process that evolves to meet contemporary educational demands, particularly in diverse and technology-mediated learning contexts.

Taken together, the definitions above provide a framework for discussing formative assessment. They highlight that formative assessment can be applied in ways that are context-specific, allowing for flexibility in its use depending on the educational setting. In the next subsection, the differences between formal and informal formative assessments as evidenced by the literature are presented and this further illustrates how educators can apply these core principles in practice, depending on their unique teaching environments and objectives.

Formal and Informal Formative Assessment

Yorke (2003) defined formal formative assessments as those that align with a specific curricular assessment framework. He suggested that they involve activities required of both students to complete tasks and assessors to evaluate work and provide feedback that supports student learning. The primary aim of these assessments, he concluded, was not merely to measure performance but to deliver valuable feedback that helps students improve their understanding and skills. Yorke (2003) also distinguished between formal and informal formative assessments, describing the latter as naturally occurring evaluations during learning activities that are not explicitly defined within the curriculum. He posited that these assessments may include spontaneous feedback provided as the student engages in learning activities, as well as teacher comments on draft work intended for portfolios. These less structured forms of feedback are important contributions to the conversation because they highlight how students can benefit from timely, situational guidance without necessarily waiting for a formal assessment event.

This contrasted with Brown's (1999) view that formative assessment is primarily characterised by its continuous nature. While Brown's view shows the value of ongoing feedback, it may overlook situations where even periodic or one-off formative checks can be highly effective, especially when students receive targeted input at critical junctures in their learning. Yorke further contended that formative assessment does not need to be ongoing to be effective, suggesting that even occasional assessments can still provide the essential support that facilitates student learning. More recent work by Broadbent et al. (2021) supports this flexible approach, especially in hybrid and online learning environments, emphasising that both structured and informal assessment practices play vital roles in enhancing student engagement and learning progression. What Broadbent et al. rightly identify is that a balanced use of formal and informal methods can adapt to varied instructional settings, providing students with feedback that is both planned and responsive to emerging needs.

Comparing Formative Assessment and Assessment for Learning

Before leaving this section, publications referring to the concept of Assessment for Learning (AfL) are introduced briefly, as the term is often used interchangeably with Formative Assessment. While both concepts share key principles, there are important distinctions.

Assessment for Learning (AfL) has emerged as a significant concept in recent years, introduced partly due to the misunderstandings surrounding the term formative assessment. At the outset of its conceptual development, Black and Wiliam (1998a), saw AfL as the purpose behind formative assessment, whereas formative assessment itself functions as a mechanism or process. They argued that assessment becomes formative when the evidence gathered is actually used to adapt teaching in response to identified learning needs (Black and Wiliam, 1998b). Their view aligned formative assessment with a process of gathering evidence, providing feedback, and guiding instruction, while AfL encompassed broader principles and practices aimed at actively involving students, fostering self-regulated learning, and promoting deeper understanding of subject matter.

Stobart (2008) treated AfL as a particular emphasis within formative assessment, focusing primarily on interactive student learning, whereas some approaches to formative assessment centre more on teacher learning, intended to lead to curricular changes that improve student outcomes. Recent literature has continued to explore these distinctions. Looney (2019) highlighted how AfL is increasingly seen as a more expansive, student-centred framework that goes beyond the traditional confines of formative assessment. Looney's stance emphasised that AfL prioritises engaging students in setting their own learning goals, participating in peer and self-assessment, and reflecting on their learning strategies. This approach is evident in digital formative assessment environments, where platforms and tools are designed to empower students as active agents in the assessment process, thus aligning with AfL's emphasis on self-directed learning and formative feedback loops (Looney, 2019). Similarly, Heitink et al. (2016) have stressed that while formative assessment focuses primarily on using evidence to inform immediate instructional adjustments, AfL integrates these activities into a broader cycle of learning, including goal setting, ongoing feedback, and reflection.

Following this review of definitions and key insights into the meaning of formative assessment, the next two Sections 2.1.2 and 2.1.3 examine the literature on the benefits and challenges of formative assessment.

2.1.2. Advantages of Formative Assessment

Addressing the topic of formative assessment, scholars such as Black and Wiliam (1998b), Sadler (1998), Yorke (2003) and Bennett (2009) highlighted several

advantages stemming from its implementation, presenting compelling arguments in its favour. This section offers a comprehensive analysis of the literature which underpins the critical role of formative assessment in nurturing a successful learning environment. Presented below are three main advantages of formative assessment: its capacity to enhance academic achievement; its ability to act as a catalyst for boosting student motivation; and the role it plays in fostering self-regulation skills both in the physical classroom environment and online.

Impact of formative assessment on academic achievement

It is evident from the literature reviewed that a common thread running throughout these studies is the direct correlation between formative assessment and enhanced academic achievement. Hattie (2009), in his synthesis of over 800 meta-analyses on student achievement, found that feedback which is a core element of formative assessment had an effect size of 0.73, ranking it among the most effective instructional strategies. Nicol and MacFarlane-Dick (2006) argued that formative assessment plays a pivotal role in enhancing student motivation and fostering self-regulation skills, offering a powerful means to engage and empower learners. Additionally, Hattie and Timperley (2007) further emphasised that timely feedback, a key component of formative assessment, is among the most significant factors influencing student achievement. Similarly, the Education Endowment Foundation (EEF) evaluation of the Embedding Formative Assessment programme found that students in intervention schools made the equivalent of two additional months of progress in their Attainment 8 GCSE scores compared to those in control schools (EEF, 2018). Wiliam (2011) highlighted how formative assessment, when embedded effectively, supports continuous instructional adjustments that improve academic results, reinforcing its importance in the learning process. The aggregate of findings from these studies supports the conclusion that formative assessment, particularly when integrated with structured feedback mechanisms, contributes significantly to student achievement. While individual studies report varying effect sizes, the consensus remains that formative assessment enhances learning, engagement, and attainment, making it a critical tool in modern education. These areas are described in more detail below.

Pryor and Crossouard (2008, 2010) saw formative assessment as taking place when student work is responded to, and evidence is provided of what constitutes good learning. Juwah et al. (2004) asserted that the central role of formative assessment in

teaching and learning in higher education is a process for providing information to teachers about the difficulties students may be experiencing so they can refocus their teaching efforts. The authors argued that formative assessment "should be an integral part of teaching and learning in HE," (p. 3). They also argued that feedback and "feed-forward," (i.e., focusing on solutions rather than mistakes and how to tackle future assigned tasks) should be central tenets of formative assessment and "systematically embedded in curriculum practices." The authors asserted that feedback on performance would enable the student to "restructure their understanding/skills to build more powerful ideas and capabilities" (p. 3).

Wu and Jessop (2018) argued that formative assessment provides feedback on performance that students can use to improve their learning while Black and Wiliam (2009) noted that the use of formative assessments may also encourage teaching staff to tailor their instruction to accommodate student requirements. These two perspectives show that formative assessment and feedback are inherently interconnected. McCallum and Milner (2021, p. 2) also argued that "formative assessment and feedback are intrinsically linked," in the learning process. They explained how formative assessment is "an ongoing process that offers students a chance to engage with the feedback information provided and improve their work and their feedback literacy," (p. 2) and one that involves the active participation of both teachers and students. They suggested that it functions as a way of monitoring student learning to provide ongoing feedback that can be used by instructors and students to improve their teaching and learning, respectively. Black and Wiliam (1998) devised a slightly different method to evaluate and monitor the effectiveness of the formative assessment process. They posed three questions regarding the process of using formative assessment in the classroom. These questions are as relevant now as they were in 1998, or when they were revisited by the authors in 2004 and 2015 and are closely linked with the research questions of this study.

The questions were:

1. Is there evidence that improving formative assessment raises standards?
2. Is there evidence that there is room for improvement?
3. Is there evidence about how to improve formative assessment?

After a comprehensive review of 250 sources, the conclusion reached by Black and Wiliam (1998) was a clear yes for each of the above questions. Their research showed

that innovations, including strengthening the practice of formative assessment, produced significant and often substantial learning gains. Kingston and Nash's (2011) meta-analysis confirmed that formative assessment, when well-implemented, leads to measurable improvements in academic achievement, particularly in literacy-based subjects. Similarly, the EEF's 2024 evaluation (Taylor *et al.*, 2024) of the EFA scale-up programme found that teachers implementing structured formative assessment strategies consistently reported improved student engagement, feedback literacy, and self-regulated learning behaviours.

Yorke (2003, p. 482) agreed that "Black and Wiliam's review confirms a belief that underpins both higher education and education in general: formative assessment is critically important for student learning."

Black and Wiliam's (1998) main findings were as follows:

- Students need to be actively involved in the learning process,
- The results of assessments have to be used to adjust teaching and learning to function formatively,
- Assessments can affect the motivation and self-esteem of pupils and the benefits of self-assessment.

Black and Wiliam also acknowledged the limitations of the research, such as the lack of large-scale studies and the need for more research on the impact of self-assessment by pupils and suggested that some of the most important questions can be answered only through a programme of practical implementation. In addition to teacher-led evaluation and feedback, self-assessment is increasingly recognised as a core element of effective formative assessment. It enables students to reflect on and evaluate their own learning, using feedback and predefined criteria to identify strengths, gaps, and areas for improvement (Boud, 1995; Andrade, 2019). As students become more engaged in self-assessment, they also build greater autonomy and develop the capacity for self-regulated learning, skills that are particularly important in technology-enhanced and blended learning environments (Panadero et al., 2019). Black and Wiliam (1998) noted the potential benefits of self-assessment but also called for further research on its impact. This study responds to that call by incorporating and examining self-assessment within the context of formative assessment and digital tools. A more detailed exploration of this concept is provided in Section 2.3.2, particularly in the subsection Self-Assessment and Self-Regulated Learning.

This study is a timely intervention because formative assessment continues to evolve in the 21st century, incorporating digital technologies and reflecting broader changes in educational practices. Looney (2019) has argued that digital formative assessment offers enhanced opportunities for real-time feedback and adaptive learning, supporting a more personalised approach to student engagement and improvement. Similarly, Heitink et al. (2016) discussed how contemporary definitions of formative assessment emphasise its role in fostering student autonomy and guiding self-regulated learning, building on earlier conceptualisations while integrating technological advancements. Studies by McCallum and Milner (2021) highlighted the importance of formative e-assessments in enhancing students' feedback literacy and offering opportunities for reflection, making formative assessment a more interactive and continuous process. Finally, Broadbent et al. (2021) also explored how formative assessment practices, especially in online learning environments, support student engagement by providing timely and actionable feedback that can be directly applied to improve learning outcomes.

How formative assessment increases student motivation and self-regulated learning

Formative online assessments have consistently been shown to play a crucial role in promoting student motivation and engagement (de Lange et al., 2003; Mo, 2011; Clark, 2012; Granberg et al., 2021). This research shows that the effectiveness of these assessments hinges on the quality of feedback provided, which must go beyond simple marks or scores as effective formative feedback should be detailed, actionable, and tailored to the individual needs of students, providing guidance that can directly inform their learning strategies (Hattie & Timperley, 2007). Motivation is a key driver of effective learning, and formative assessment plays a central role in enhancing both intrinsic and extrinsic motivation (Shepard et al., 2018). The authors concluded that intrinsic motivation thrives when students are genuinely interested and personally invested in their learning. Formative assessments that offer meaningful, constructive feedback help to nurture this interest by making the learning process more relevant and engaging. Nicol and MacFarlane-Dick (2006) argued that when feedback is designed to motivate, it encourages students to take ownership of their learning by setting goals, monitoring their progress, and adjusting strategies as needed. This cycle of self-regulation is crucial for developing lifelong learning habits and academic resilience. As students witness their incremental progress, intrinsic motivation is reinforced, leading

to sustained engagement (Panadero et al., 2019; Broadbent et al., 2021). These authors concluded that extrinsic motivation, meanwhile, can be shaped by clear and achievable goals established through formative assessments. Regular feedback allows students to measure their performance against set learning objectives, providing a sense of accomplishment when targets are met. Weurlander et al. (2012) demonstrated that formative assessments not only motivate students to study but also enhance metacognitive awareness by encouraging reflection on their learning progress and helping them identify areas for improvement. They suggested that this reflective process plays a significant role in fostering both intrinsic and extrinsic motivation by helping students internalise learning goals and connect them to tangible outcomes.

Several studies have further drawn attention to the motivational benefits of formative assessment, especially in online and blended learning environments. For example, Granberg et al. (2021) found that formative e-assessments, when designed with clear learning objectives and interactive features, can significantly enhance student engagement by providing immediate, personalised feedback. This real-time response allows students to correct misunderstandings and refine their learning approaches before misconceptions take hold. Additionally, formative assessments are particularly empowering when embedded in environments that encourage autonomy and provide students with a clear sense of progress (McCallum and Milner, 2021). Carless (2015) emphasised that formative assessment is critical for promoting self-regulated learning, particularly through practices that involve dialogic feedback. He explained that formative approaches that encourage students to actively engage with feedback help to deepen their critical thinking skills and overall engagement. Carless further suggested that the iterative nature of formative assessment supports students in acting on feedback, enabling them to take a proactive role in their learning journey. According to Carless, when regular formative assessments are paired with opportunities for reflection and dialogue, educators can create a learning environment that nurtures both intrinsic motivation and self-directed learning.

Online Formative Assessment

As formative assessment practices have evolved, the integration of technology has brought new dimensions to its implementation, particularly in online settings. This subsection briefly explores how online formative assessments offer distinct advantages, including immediate feedback and scalable learning environments, as highlighted in

recent studies. Literature that focuses on the role of technology in formative assessment will be examined in much more detail in Section 2.3. As Einig (2013) observed, online assessments provide unique advantages, particularly their ability to offer immediate feedback tailored to students' learning approaches. This immediacy is especially significant for multiple-choice formats, where swift feedback has been shown to significantly enhance learning outcomes. Velan et al. (2002) also noted that online systems allow tutors to track student performance more efficiently, reducing the burden of grading and enabling timely interventions. Despite these advantages, Einig cautioned that such systems might risk fostering surface learning if the feedback lacks depth, a concern explored further in Section 2.3.3 on the drawbacks of formative assessment.

McCallum and Milner (2021, p. 2) expanded on these benefits by describing "feedback-rich formative e-assessments" as digital tools that integrate feedback directly into the learning process, rather than as supplementary components. They argued that this feedback must be continuous and targeted, to effectively guide student improvement and learning. It emphasises feedback as an integral part of the learning process rather than as a mere add-on after the assessment.

Sim et al. (2004) similarly explored the existing literature on computer-assisted assessment, highlighting how it has been adopted in response to the growing need to handle larger class sizes and provide scalable assessment solutions. Although their work reflected a broader movement towards automating assessments in higher education, it aligned with findings from Nicol and colleagues (Nicol & Macfarlane-Dick, 2004; Nicol & Milligan, 2006), who emphasised the role of ICT in facilitating formative assessment. In particular, Nicol (2006) focused on how technology can support large first-year cohorts, when delivering personalised feedback remains a challenge. Similarly, Carless and Boud (2018) recognised that computer-based systems act as valuable reservoirs of data, enabling more personalised, efficient, and consistent feedback loops. They suggest that these systems not only streamline the feedback process but also provide opportunities for students to engage with the feedback in an ongoing, iterative manner, thereby enhancing their learning experience. More recent studies, such as those by Dawson et al. (2019) and Molloy, et al. (2020), have further emphasised the benefits of technology-enhanced formative assessment. These studies concluded that while e-assessments can scale efficiently, the quality of feedback remains paramount. They highlighted that simply automating assessments is

insufficient. The richness of feedback, opportunities for dialogue, and iterative learning cycles are crucial to making these systems genuinely effective. This focus on the quality of feedback aligns with broader literature discussed in Section 2.3.2, which examines the benefits of technology-enhanced formative assessment in greater detail.

2.1.3. Drawbacks in using Formative Assessment

Although formative assessment is widely recognised for its role in enhancing student learning, putting it into practice presents several challenges. The literature identifies key issues, such as the considerable time and resource demands placed on educators, the complexities of balancing formative and summative assessments, the complexities in measuring the effectiveness of formative feedback, and the lack of robust theoretical grounding that underpins its use in higher education.

The time and resource demands of effective formative assessment

As shown earlier in this review, the implementation of formative assessment is widely recognised for its role in enhancing learning through feedback, but it also presents significant challenges, particularly in terms of the time and effort required from educators. Studies have shown that providing feedback, particularly in large classes, is demanding. For example, Einig (2013) noted that delivering frequent, high-quality feedback is time-consuming and can strain teaching resources, especially when it is primarily the responsibility of teaching staff, as is common in the UK. Researchers have also discovered that this challenge is further complicated by the need to balance formative and summative assessments. Price et al. (2010) concluded that while summative assessments often lend themselves to more streamlined, technology-assisted approaches, formative assessments require a more tailored approach that is responsive to the needs of individual students, and that requires time. The importance of allocating sufficient time for various aspects of formative assessment, especially when technology-enhanced methods are involved, is also identified in the literature. Blair et al. (2016) emphasised the need for dedicated time in the setup, implementation, and training phases, while Çakıroğlu et al. (2016) highlighted the ongoing demands of maintenance and support. Wiliam (2011) argued that although formative assessment, when aligned with instructional practices, offers a coherent framework that benefits both teaching and learning, it demands significant effort from educators.

The challenge of balancing summative and formative assessments

Many studies have found it difficult to assess the effectiveness of assessments, because they include both formative and summative elements (Dawson et al., 2019). Therefore, it is challenging to obtain a clear picture of the impact of purely formative assessments. Bennett (2011, p. 12) pointed out that "defensible assertions about the impact of formative assessment are very difficult to make." Andrade (2019) echoed this concern, arguing that the integration of formative and summative assessments can create conflicting goals, where formative assessments risk becoming mere stepping stones towards summative evaluations, rather than focusing on promoting learning. McCallum and Milner (2021) addressed this issue by considering the effectiveness of a series of formative e-assessments introduced across two first-year courses. These were carefully designed with reference to best practice (Gibbs & Simpson, 2004; Nicol, 2009) to maximise potential effectiveness. The McCallum and Milner study found that formative assessment effectiveness is improved by focusing on student perceptions of the impact of assessment on their own performance and learning engagement. Those researchers said (p. 2) that "This view of effectiveness contrasts with some other studies (e.g. Perera et al., 2014) that focus solely on the improvement of student results." Their study adds to existing studies by shedding light on the staff's view of formative assessments, a significant aspect that is frequently neglected.

Difficulty in determining the effectiveness of formative assessment

Research consistently highlights the value of formative assessment in supporting student learning, yet determining its effectiveness remains a complex challenge. Several early studies (e.g. Wiliam and Thompson, 2008; Redecker and Johannessen, 2013) showed that students overwhelmingly value organised formative assessment sessions. However, even earlier, Yorke (2003, p. 483) argued that beyond the students' positive responses, two critical questions must be addressed when evaluating the effectiveness of formative assessment: "Is what the assessor has done regarding feedback the best that could have been done? And … did the feedback influence student behaviour?" He further noted that measuring effectiveness "if the action-feedback-learning-new action spiral is very tightly circumscribed and controlled," is rarely feasible in real-world educational settings (p. 492). He suggested that learning in higher education is influenced by a wide range of factors beyond formative assessment, including external events, student backgrounds, and the quality of instruction. He emphasised the

challenge of isolating the specific impact of formative assessment on student learning, as these interacting factors can obscure its effects. Building on this, Nicol (2021) argued that the effectiveness of formative assessment depends on students' internal processing of feedback. He emphasised that student engagement with, and interpretation of feedback, are critical in determining its impact on their learning, suggesting that formative assessment's success depends on more than just the quality or timing of the feedback. This perspective shifts the focus from the feedback itself to the active role students must play in making sense of it. These studies therefore suggest that while formative assessment has significant potential to enhance learning, its effectiveness is mediated by complex factors such as student agency, the feedback delivery process, and broader educational contexts.

Lack of deep theoretical paradigms of formative assessment in higher education

Despite the widespread recognition of formative assessment's value for student learning, its application in higher education still lacks a strong theoretical foundation. Yorke (2003, p. 477) concluded that although formative assessment is seen as essential, it is often not fully understood across different educational contexts. He argued that a deeper approach is needed, one that considers how knowledge is built and understood differently across subjects, how students' thinking skills develop over time, and how feedback can be given in ways that truly support learning.

More recently, Morris et al., (2021) highlighted the scarcity of high-quality, causal evidence in the field, calling attention to the need for more rigorous research in higher education contexts. Nicol (2021) supported this by pointing out that formative assessment involves complex processes, particularly related to the internal feedback students generate when they compare their work against various sources, like previous work, criteria, or examples. Nicol stressed that much research on feedback has overlooked these internal processes, which are key to helping students guide their own learning. As students work through tasks, they create "internal feedback," by comparing their efforts with different references, a process Nicol highlighted as crucial for their learning and development. He further noted that a significant challenge lies in the need for educators to implement feedback systems that not only address students' immediate needs but also support their cognitive and metacognitive growth. According to Nicol, feedback should prompt students to actively engage in comparison processes that foster deeper learning and better self-regulation. Nicol (2021) concluded that, while feedback

systems are essential, the way to consistently apply these processes in practice remains unclear. This limitation was echoed by Winstone and Carless (2020), who argued that formative assessment is sometimes disconnected from subject-specific thinking or fails to acknowledge the varied learning paths of students. As a result, opportunities to fully engage students or use feedback effectively are often missed. Winstone and Carless (2020) further pointed out that, while formative assessment seeks to offer students valuable insights into their learning, its impact can be reduced by the absence of a clear structure linking feedback to student motivation and learning outcomes. To improve practice, they argued, educators must develop a stronger understanding of how formative assessment can be tailored to meet both individual and disciplinary needs.

Despite the challenges described above, technology offers opportunities that can help address some of the drawbacks of formative assessment. For example, automated feedback systems and online platforms streamline the process of providing timely, consistent feedback, reducing the burden on educators (Dawson et al., 2019). However, these systems also present challenges, including the risk of overly generic feedback, difficulties in adapting to complex tasks, and potential reductions in opportunities for meaningful student engagement. Additionally, digital tools allow for more frequent assessments, personalised feedback, and greater opportunities for self-regulated learning (Carless & Boud, 2018, Nicol, 2021). These benefits, discussed further in Section 2.3.2, illustrate how technology can potentially enhance the effectiveness of formative practices and overcome some of the practical challenges faced in traditional settings.

2.2. Studies on the Impact of Feedback

While the literature reviewed above clearly highlights just how critical feedback is when it comes to formative assessment in any setting, this section addresses the existing literature surrounding feedback in higher education in particular. It presents various definitions of feedback, its effectiveness, and implementation. Advantages and challenges are evaluated, along with contributions from key scholars in the field. At the end of this section, a transition to the next section highlights the role of technology in bolstering the provision of effective feedback.

2.2.1. Defining Feedback

The literature consistently emphasises the importance of developing strong strategies to ensure that feedback is effective in supporting student learning and engagement. In

education, feedback is widely regarded as a vital pedagogical tool, central to the teaching-learning ecosystem. Hattie and Timperley (2007) described it as a process through which information about students' performance and understanding of specific learning tasks is communicated. This feedback, they argued, helps students identify their strengths, recognise their weaknesses, and ultimately fosters their overall academic growth. In their extensive exploration of the nature of feedback, Hattie and Timperley (2007, p. 81) asserted that "feedback is conceptualized as information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding." This assertion highlights the many different places feedback can come from, showing how broad and important it is. In a complementary vein, Carless (2015, p. 192) offered a more dynamic interpretation of feedback. He posited that feedback is "a dialogic process in which learners make sense of information from varied sources and use it to enhance the quality of their work or learning strategies." These perspectives reiterate the idea that feedback is an interactive process, not just the passive receipt of information.

It is these many and varied characteristics of feedback that explain why Hattie and Timperley (p. 104) confidently asserted that "feedback is one of the most powerful influences on learning." Collectively, these views provide a more detailed understanding of feedback, as not only a diverse and dynamic tool, but also as a pivotal force in learning and skill development. Dawson et al. (2019) have identified key additional elements of this point. First, they (p. 25) noted that since the early 2010s the literature "has shifted to view feedback as a process that students do where they make sense of information about work they have done, and use it to improve the quality of their subsequent work." Secondly, Dawson et al. (p. 34) explained that they have a more modern definition of feedback as "a process, designed by educators, undertaken by learners, which is necessarily about improvement." Another key aspect of feedback that emerges from the literature is that it helps to create an engaging learning environment and encourages students to take responsibility for their learning. As Nicol and Macfarlane-Dick (2004, p. 4) pointed out, it is important to "conceptualise feedback more as a dialogue rather than information transmission." Furthermore, Hattie and Timperley (2007, p. 102) emphasised the importance of constructive feedback by stating that it is "most effective when it aids in building cues and information regarding erroneous hypothesis and ideas and then leads to the development of more effective and

efficient strategies for processing and understanding the material." Thus, it is clear that effective feedback in higher education involves not just identifying areas for improvement, but also providing strategies and guidance on how these improvements can be made.

Hattie and Timperley (2007) further explored the strategic delivery of feedback, including its implications and inherent challenges. Their research underscored that feedback is "most powerful when it addresses faulty interpretations, not a total lack of information" (p. 82). Moreover, Nicol and MacFarlane-Dick (2006) also asserted that feedback is integral to instructional processes and a key tool in developing self-regulated learning. They further emphasised the significance of integrating self-assessment within the feedback process. McCallum and Milner (2021) reported that the educational literature had established that feedback is an active process, rather than simply the transmission of information. For the feedback process to be effective, students must decode information received and take action (Nicol, 2010; Carless & Boud, 2018). In looking at the difference between summative and formative assessment, Harlen and James (1997, p. 372) pointed out that while information can be delivered in a variety of ways, formative assessments are often the vehicle of choice, as they can focus not only on promoting learning but also on providing "diagnostic information," to both students and staff. They argued that this diagnostic feedback allows both parties to adjust their strategies where students can modify their approach to learning, while educators can tailor instruction to meet learners' changing needs. This dual focus highlights formative assessment as a key mechanism for enabling actionable feedback that informs ongoing learning.

Formative assessment and feedback

McCallum and Milner (2021) pointed out how formative assessment and feedback are intrinsically linked in the learning process. Feedback allows students to "understand their strengths and weaknesses" (p. 3), guides them on how to improve, and it also allows teachers to adjust their instruction based on the needs and understanding of the students. Therefore, the authors noted, the two are inextricably linked through a cycle of continuous learning and improvement. They summed up by concluding that "Formative assessment focuses on promoting student learning, by giving information on performance that students can act on, and by ensuring staff adapt teaching to meet student needs (p. 2)." Gauntlett (2007. p. 11) expanded on this relationship, pointed out

that “when feedback is used in formative assessment, it can be called “formative feedback”. This then places emphasis on the recipient’s role in processing the feedback and then using it constructively.” Ramaprasad (1983, p. 4) made a related point asserting that “feedback is information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way.” These perspectives underline the reciprocal nature of formative feedback, where both students and educators contribute to closing learning gaps and enhancing performance.

Studies have also foregrounded the importance of ensuring that feedback maintains a focus on what might be called “big-picture” learning. Rushton (2005) offered an insightful analysis of the educational impact of formative assessment on deep learning. She supported her position by citing Hattie and Jaeger’s (1998) synthesis of meta-analyses, which found that feedback creates “the most powerful single effect on achievement” (Hattie and Jaeger, p. 114). However, Rushton critiqued Black and Wiliam’s (1998a) narrow definition of feedback, adopting a broader perspective that focuses on enhancing learning. She explored the dual nature of feedback, noting that both teacher and student are actively involved in a process that hinges on their ability to give or receive feedback, with “the teacher providing feedback and the student receiving feedback,” (p. 509). This broader perspective aligns with Hattie and Jaeger’s (1998, p. 113) assertion that feedback is the “provision of information related to the understanding of the constructions that students have made from the learned/taught information,” and is “polymorphous, referring to subsequent information aimed at assisting the learner in meeting the goals of the learning process.” Hattie and Jaeger further explained that the notion of “subsequent” differentiates the information provided during instruction from the feedback that follows, which is specifically aimed at helping the learner progress toward their learning goals. Rushton’s analysis bridges these views by emphasising the dual roles of feedback in promoting understanding and enabling targeted interventions, reinforcing its critical role in deep learning processes.

Feedback Literacy

The literature also stresses the importance of ensuring that high quality feedback is provided and that learners can understand and act on it. Carless and Boud (2018) recognised the need to ensure that the feedback provided is of a sufficient quality to facilitate the development of students’ feedback literacy. They define feedback literacy “as the understandings, capacities and dispositions needed to make sense of information

and use it to enhance work or learning strategies," (p. 1316). Consequently, they suggested that educational professionals must examine how students respond to feedback and identify strategies to support and enhance this engagement. There is widespread agreement in the literature on this view. Winstone et al. (2017, p. 17) stated that while there had been a considerable body of literature on the topic of "effective feedback and how to deliver it," they suggested that "it is equally important to understand how learners actively receive, engage with, and implement feedback." Likewise, McCallum and Milner (2021, p.2) stated that "It is important to consider the students' views of feedback and to ensure that feedback messages are clear in order to enhance feedback literacy and feedback recipience." Therefore, they suggested that it is essential that feedback is viewed as an ongoing process that offers students a chance to engage with the feedback information provided and improve their work and their feedback literacy.

Building feedback literacy is a complex and challenging process (Sutton, 2012), hence it is important to begin in the first year of a programme. Molloy et al. (2020) said that this early exposure offers students the chance to engage with feedback, actively respond to it, and develop deep learning strategies. Carless and Boud (2018) explained that feedback must be understood as a continuous process, allowing students to interact with the information provided, thereby improving both their work and their capacity for feedback literacy.

This emphasis on the continuous and interactive nature of feedback is crucial given its persistent weaknesses in practice, as highlighted in broader studies. For example, Guo et al. (2013, p. 370), after reviewing data from the Higher Education Funding Council for England (HEFCE) National Student Survey (2007–2010), concluded that "it is surprising that as one of the most important communication methods between teachers and students, feedback was one of the weakest areas." Similarly, Malau-Aduli et al. (2014, p. 510) agreed that "the central role of feedback in student learning is well recognised; however, it is often one of the poorest scoring items in Student Evaluation of Teaching and Learning (SETL) surveys." They suggested that educators also require feedback regarding the quality of the assessments they administer. Collectively, these studies agree on the need for improved feedback practices that are actionable, transparent, and supported by both students and educators.

2.2.2. Effective Feedback

A recurring theme in the literature (Einig, 2013; Y1Feedback Report, 2016; Winstone and Carless, 2020) is that feedback exerts a powerful influence on learning, particularly when it is timely, task-specific, and closely aligned with learning goals. Einig (2013) observes that "feedback has been consistently found to have a powerful influence on learning and achievement … but, in order to be effective, the feedback should be task-specific, contain learning-related information, and be timely and informative." Yet, large class sizes can strain teaching resources, making it difficult for instructors to provide frequent and high-quality feedback. Similarly, NFETL (2017) notes that a positive classroom environment alone does not guarantee effective feedback, pointing to overlooked factors such as metacognition and scaffolding that nurture self-regulatory learning. Y1Feedback Report (2016) synthesises seminal works (e.g., Hattie & Timperley, 2007; Sadler, 2010; Carless et al., 2011) to emphasise feedback's role in fostering motivation, confidence, and deeper engagement, especially during transitional phases. Building on this, Winstone and Carless (2020) further advocate a dialogic model, in which feedback is not merely transmitted to students but is actively co-constructed, enabling them to reflect on and apply it for continuous improvement. This shift from one-way delivery to reciprocal engagement highlights the importance of designing feedback processes that encourage interaction, reflection, and, ultimately, greater learner autonomy.

Studies have identified several characteristics that provide the hallmark of effective feedback. Synthesising the work of Race (2007), Irons (2008), and Juwah et al. (2004), researchers Guo et al. (2013, p. 370) asserted that "to make the feedback effective and meaningful, a range of quality attributes need to be achieved." They suggested "that in order to improve learning gains, formative feedback should address as many as possible of the following attributes, including constructive, motivational, personal, manageable, timely and directly related to assessment criteria and learning outcomes."

Nicol (2007, p. 2) recounted how he:

> became increasingly aware of the challenge facing busy teachers as they tried to make sense of the vast body of published research on assessment. I believed that if some basic principles could be extracted from the research, these would help teachers think about and identify ways of improving their practices.

Nicol and MacFarlane-Dick (2006, p. 205) concluded that "good feedback practice is broadly defined here as anything that might strengthen the students' capacity to self-

regulate their own performance." A synthesis of the research literature by these authors identified seven core principles for effective feedback: clarifying performance standards, promoting self-assessment, providing high-quality information about learning progress, fostering dialogue, encouraging motivation and self-esteem, offering opportunities to close performance gaps, and generating information to inform future teaching. Nicol (2007, p. 5) explained that "The guiding idea behind these seven principles was that, if implemented, they would help enhance students' responsibility for, and control over, their own learning." This principle is echoed in the work of Dawson et al. (2019), who conducted a comprehensive literature review and identified high-quality feedback information as crucial for effective feedback. According to these authors, the usability of feedback comments from the students' perspective is a significant factor, with students valuing feedback that is detailed, affective, and specifically related to their work. Dawson et al. (2019, p. 34) found that "the most common feature of comments that made them effective from the student perspective was that they were usable," highlighting the importance of applicability in feedback.

The literature highlights that the effectiveness of feedback is influenced by both its design and its ability to foster motivation, making it a key focus for improving learning outcomes. From the staff's perspective, effective feedback hinges on design considerations such as timing, modalities, and connected tasks (Dawson et al., 2019). This contrasts with the students' emphasis on the quality and usability of the feedback comments. These authors further observed that both staff and students' experiences reflect Sadler's (2010) findings that the relationship between feedback's form, timing, and effectiveness is complex and variable, with no universal solutions. Sadler (2010, p. 536) noted, "At the risk of glossing over the complexities of what is known about feedback, the general picture is that the relationship between its form, timing and effectiveness is complex and variable, with no magic formulas." Motivation also plays a critical role in feedback effectiveness. Intrinsically motivated students, driven by their interest in the subject, seek more meaningful feedback beyond mere grades to engage deeply with the material (Fleckhammer & Wise, 2010). On the other hand, those scholars concluded that the effectiveness of feedback is compromised if students do not utilise it to understand their grades and improve future performance. Fleckhammer and Wise (p. 344) asserted that,

> While there is general consensus that providing feedback is a resource intensive process, has to be delivered in a timely fashion and should be consistent across

> markers, the effectiveness of feedback is brought into question if students do not use it to understand the reason for their numerical grade, and to facilitate their performance on future assignments.

Harks et al. (2014) highlighted their findings that more elaborated, specific feedback is perceived as more useful than brief, general feedback. They suggested that such detailed feedback helps correct erroneous knowledge, enhances self-evaluation accuracy, and boosts students' confidence and interest in the subject. This is particularly crucial for fostering a deeper understanding and engagement with the learning material. Nonetheless, Hattie and Timperley (2007) cautioned that feedback is only effective when it builds on existing learning. They concluded that without an initial foundation of knowledge, feedback is of little use. As a result, they advocated for more extensive research into how feedback functions in the classroom and the learning process, as feedback is one of the most powerful yet underutilised influences on learning. Together, these studies show that effective feedback requires thoughtful design and attention to usability. They also emphasise the importance of fostering motivation to maximise its impact on student engagement and academic performance.

Importance of Positive Feedback

The pivotal role of positive feedback within educational contexts is well-documented. Hattie and Yates (2013) emphasised that positive feedback can enhance student motivation, self-esteem, and engagement. Shute (2008) pointed out that formative feedback, when used effectively, helps learners move towards a state of competence by attending to and acting on relevant cues. Recent research highlights the importance of relational aspects in feedback delivery. Empathy and kindness, as discussed by Cain et al. (2023) and Ryan et al. (2024), are critical in fostering a supportive feedback environment, which can significantly enhance students' emotional resilience and sense of belonging. Such relational intent ensures that feedback contributes to students' engagement and intrinsic motivation, making it a powerful tool for positive reinforcement (Mercer and Gulseren, 2024). Nonetheless, the literature also presents a cautionary note. Brophy (1981) argued that praise must be sincere and deserved, else it can lead to complacency and obstruct growth. He noted (p. 27) that:

> Rather than just assume its effectiveness, teachers who wish to praise effectively will have to assess how individual students respond to praise, and in particular, how they mediate its meanings and use it to make attributions about their abilities and about the linkages between their efforts and the outcomes of those efforts.

To maximise its benefits, positive feedback must align with students' sensemaking processes and provide actionable, specific comments. This alignment not only reinforces students' strengths but also ensures that feedback contributes meaningfully to their learning and development (Cain et al., 2023; Ryan et al., 2024).

Impact of Negative Feedback

Negative feedback refers to evaluative comments or observations highlighting areas of deficiency, mistakes, or missed opportunities in performance (Kluger and DeNisi, 1996). When delivered constructively, negative feedback can be a powerful catalyst for improvement, offering learners clear directions for refining their skills. Kluger and DeNisi (1996) demonstrated that negative feedback can prompt significant change when it includes actionable strategies for improvement. However, its delivery requires careful consideration, as poorly executed feedback risks discouraging learners, fostering anxiety, and undermining motivation (Hattie and Timperley, 2007).

Mercer and Gulseren (2024) found that negative feedback often elicits unintended psychological and emotional consequences, such as decreased self-efficacy, frustration, and anxiety. These effects are particularly pronounced when feedback is vague, overly critical, or lacks actionable guidance. Similarly, Ryan et al. (2024) highlight the importance of balancing feedback to ensure it motivates rather than alienates students. They argue that feedback needs to support sensemaking and provide students with a path to improvement.

Delivering effective negative feedback poses substantial challenges for educators. As Voerman et al. (2012) noted, balancing positive and negative feedback while ensuring both are specific and actionable is a nuanced skill. Feedback literacy, defined as the understanding, capacities, and dispositions needed to apply feedback effectively, is crucial for both educators and learners. Cain et al. (2023) emphasised that fostering feedback literacy helps learners engage with feedback constructively, transforming potentially demotivating experiences into opportunities for growth.

2.2.3. Effective Feedback Challenges

The literature supports the position that feedback does not operate in a vacuum, because the learning environment and context significantly influence the effectiveness of feedback practices. In high-stakes exam contexts, for instance, student-led feedback practices might be less prevalent (Hattie & Timperley, 2007). Furthermore, as noted earlier, feedback in formative assessments is not an isolated act but a process involving

a feedback loop. For it to be effective, students must actively engage with the feedback to produce improved work, thereby completing the loop (Sadler, 1989; Brookhart, 2008). Winstone et al. (2017) stated this requirement for active student engagement is vital for confirming the effectiveness of feedback and ensuring that learning outcomes are achieved. Despite students' demands for prompt feedback, Fleckhammer and Wise (2010, p.344) argued that "feedback for many students is not read, acted upon or even understood." This highlights a fundamental challenge: the necessity of students comprehending and using the feedback provided. Nicol (2007) supported this, noting that students often underperform in assessments due to a lack of understanding of the requirements and emphasising that students cannot self-regulate for academic success without a clear understanding of what is expected. This means that educators must ensure clarity in their feedback, focusing on explicit goals and criteria that guide students in aligning their efforts with expected outcomes, thereby enabling effective self-regulation.

However, studies have shown that what happens after the feedback has been provided is often just as important as the feedback itself. The identification of strengths and weaknesses in student work, as reported by Dawson et al. (2019), often lacks the follow-up needed to explain how students can use that information to improve. Dawson et al. argued that this reflects an outdated, information-centric understanding of feedback, where the focus is on informing students about the quality of their work rather than guiding them on how to enhance it. Interestingly, they also found that fewer educators mentioned the quality of feedback information, suggesting a potential area for improvement in feedback practices.

As has been evidenced in this chapter, the role of feedback in the learning process is extensively debated in educational literature. On one hand, feedback is considered crucial to the learning experience (Heinrich et al., 2009). When paired with formative assessment, individualised feedback enables students to actively construct their learning (Nicol & Macfarlane-Dick, 2006). On the other hand, many students are reported to ignore comments on their summative assessments, focusing only on feedback that could improve their grades on future assessments (Fleckhammer & Wise, 2010). Indeed, studies have also shown that, while feedback generally has a positive impact, its effectiveness varies. For example, Harks et al. (2014) noted that not all types of feedback are equally effective. Specifically, feedback at the self or personal level, such

as praise, is rarely effective in enhancing learning. When feedback focuses on the self, students tend to avoid challenging assignments, minimise effort, and develop a high fear of failure (Hattie & Timperley, 2007). Furthermore, Hattie and Timperley (2007) critiqued the use of testing primarily as a measure of change rather than a tool to enhance learning, noting that such accountability tests yield minimal feedback returns relative to their high costs. They also argued that feedback can only build on existing learning, and it is ineffective without an initial foundation of knowledge. Therefore, these authors suggested that, in certain cases, instruction may surpass feedback in effectiveness, particularly when there is no initial learning to build upon.

Drawing this section of the literature review to a close, it is clear that feedback, in all its various forms, is a pivotal mechanism within the educational process. It serves as a dialogic tool, bridging the gap between current understanding and desired learning outcomes. Despite its importance, the challenges associated with providing effective feedback cannot be understated. Educators face the complex task of ensuring their feedback is both affirming and constructive, guiding students towards improvement without compromising the students' motivation.

2.3. The Use of Technology in Formative Assessment

This section explores the integration of technology in formative assessment, focusing on its role in enhancing teaching and learning practices. It begins by situating technology within the broader educational context and its impact on assessment, followed by an examination of literature on the specific benefits technology offers for formative assessment, such as fostering self-regulated learning, improving feedback provision, and increasing motivation and engagement. Literature on the challenges associated with technology use, including cultural barriers, workload concerns, and feedback quality, are then reviewed. Finally, the research gaps in TEL and their implications for future practice are discussed.

2.3.1. Technology and Education Context

The educational landscape is continuously changing, shaped by shifts in pedagogy, policy, and learner needs. Digital technologies have increasingly become integral to this environment, facilitating new approaches to teaching, learning, and assessment (NFETL, 2014). While some contend that digital technologies act more as enablers than as primary drivers of educational change, their integration undeniably impacts both the methods and content of student learning (HEA, 2019). The integration of digital

technologies in formative assessment has altered educational practices significantly by enhancing the immediacy, personalisation, and adaptability of feedback (UNESCO, 2023). However, this transformation is not without challenges. For instance, digital literacy disparities among students and educators can hinder the effective use of technology in assessments (Bennett et al., 2017). Additionally, ethical concerns regarding data privacy and the potential depersonalisation of learning experiences must be carefully navigated (Higher Education Authority, 2019).

Numerous studies at both national and international levels have examined the integration of digital technologies across teaching, learning, and assessment (Kiersey, Devitt and Brady, 2018; Gaebel et al., 2021; Selwyn et al., 2021; Zhang, 2022; UNESCO, 2023). In the Irish context, initiatives like the National Forum for the Enhancement of Teaching and Learning in Higher Education have developed strategic roadmaps that encourage leveraging digital tools to enhance student learning outcomes (NFETL, 2015). These roadmaps highlight the necessity for educators to adopt practices that align with evolving pedagogies while maintaining a focus on research-driven strategies (NFETL, 2018). The emphasis in these initiatives is twofold: enhancing the digital proficiency of academic staff and validating the effectiveness of digital assessment tools. Educators are increasingly encouraged to integrate Technology-Enhanced Assessments (TEAs) within their teaching frameworks, ensuring that such practices are supported by evidence and scholarly consensus (DES, 2011). The NFETL Roadmap (2015) acknowledges that while digital tools offer transformative possibilities, their implementation must be guided by principles of accessibility, inclusivity, and pedagogical integrity. This aligns with calls for a balanced approach that integrates technology without compromising the personalisation and meaningful interaction that underpin effective assessment (Higher Education Authority, 2019). Moreover, the expansion of higher education and increasing class sizes have placed traditional assessment models under pressure, prompting a shift towards more scalable formative approaches, including digital assessments (Malau-Aduli et al., 2014). Computer-Based Assessments (CBAs) have emerged as efficient means of managing large student cohorts, offering the flexibility to self-assess and receive immediate feedback, independent of time and place (Miller, 2009). These advancements highlight the growing role of digital technologies in addressing the challenges of traditional

assessment models, particularly through the provision of flexible and immediate feedback solutions suited to larger cohorts.

In the Irish higher education system, digital technologies have been identified as central to creating efficient, customised, and inclusive feedback channels (NFETL, 2014, 2015). Furthermore, the UNESCO GEM Report (2023) and the Higher Education Authority (2019) emphasised the importance of ethical considerations and data security, highlighting the need for responsible and well-considered integration of technology in formative assessment. While this subsection provided an overview of the literature and policy that addresses the shifting educational landscape and the role of technology in formative assessment, the next subsection explores the specific advantages of a digitised educational environment, focusing on how these technologies can enhance learning outcomes and student engagement.

2.3.2. Benefits of Technology Enhanced Formative Assessment

The use of TEFA strategies go beyond merely serving as a diagnostic tool for student learning; it has transformative potential, bringing together various dimensions of the educational experience (Gikandi et al., 2011). The sections below examine the literature that consider the impact of technology-enhanced formative assessment on higher education, focusing on six important educational benefits that were identified in the literature: self-assessment, motivation and engagement, feedback provision, academic achievement, performance monitoring, and equity and flexibility. Through an examination of these interrelated dimensions, this section of the review aims to offer a holistic understanding of the transformative potential of TEFA.

Self-Assessment and Self-Regulated Learning

This section reviews literature that examines the link between self-assessment and self-regulated learning, explaining how TEFA augments student agency, problem-solving skills, and self-efficacy. The integration of self-assessment mechanisms fosters autonomous and independent learning, thereby curtailing negative cyclical patterns of test anxiety (Nicol, 2009; Andrade, 2019; Clarke and Luna-Bazaldua, 2021). The integration of self-assessment and self-regulated learning mechanisms within technology-enhanced formative assessment has been found to augment students' understanding of educational objectives, thereby fostering greater autonomy and independent learning (Broadbent et al., 2021). Duff and Mladenovic (2015) advocated for pedagogical approaches that empower students to exercise greater agency in their

learning trajectories. These approaches aim to heighten students' problem-awareness, encourage help-seeking behaviours, and strengthen their self-efficacy. Such educational interventions are particularly pivotal to "disrupt the expected vicious circle of decreasing self-efficacy and increasing test anxiety" (Blondeel et al., 2023, p. 4). These studies suggest that integrating self-assessment mechanisms within TEFAs fosters a proactive learning environment, enabling students to overcome barriers like test anxiety while strengthening their autonomy and problem-solving skills.

As discussed in Section 2.2, feedback is a fundamental component of formative assessment, and it becomes even more impactful when mediated through technology. TEFAs provide students with timely, tailored feedback that supports deeper engagement and understanding of the course material (Blondeel et al., 2023). Through features such as automated quizzes and interactive feedback loops, TEFAs enable learners to identify strengths and weaknesses in real-time, fostering self-regulated learning and enhancing their academic confidence. Blondeel et al. (2023, p. 4) explained how Online Formative Assessments (OFAs) "enable students to verify their knowledge of the subject matter and apply the theory in new exercises, allowing them to critically reflect on their learning needs." Furthermore, Bennett et al. (2017, p. 677) highlighted the role of technology in encouraging students to self-test their understanding, thereby freeing class time for targeted teaching or remedial support. In this way, TEFAs not only provide actionable insights to students but also allow instructors to focus on more nuanced pedagogical interventions. In the context of regular, low-stakes assessments, Bennett et al. also noted that weekly online quizzes for small marks are often used to motivate students to stay engaged and complete assigned readings consistently. This use of technology fosters sustained effort and preparation, encouraging students to remain actively involved in their learning over time.

Continuous testing and feedback are less common in universities than in secondary schools (Vanstone & Hicks, 2019). However, TEFAs are well-positioned to ease the transition into higher education by fostering self-efficacy and reducing performance-related anxieties (Blondeel et al., 2023). These assessments help students acclimatise to the academic expectations of higher education, promoting confidence in their abilities through regular feedback and opportunities for self-regulated learning. Blondeel et al. (2023, p. 5) stated that "self-efficacy thus forms an important link between students' learning context…and learning outcome variables, here measured with test anxiety."

Similarly, Gikandi et al., (2011) emphasised how formative assessments create learner-centred environments that support student progress, collaboration, and constructive feedback. Together, these mechanisms foster a sense of academic preparedness, helping to alleviate the uncertainties students face when transitioning to university.

Finally, in discussing how TEFAs can adapt to various student needs, Bennett et al. (2017, p. 678) observed that new assessment designs "were created or adjusted in response to student behaviors." This responsiveness is evident in the use of interactive quizzes that provide immediate feedback to sustain engagement. They can also provide options for students to select topics that foster self-directed learning, and randomised question banks that minimise cheating. Additionally, alternative formats and flexible deadlines address inequitable access to technology. Taken together, these measures illustrate how TEFAs can evolve to meet diverse challenges, ultimately promoting more inclusive and learner-centred assessment practices.

Motivation and Engagement

Technology-enhanced formative assessment serves as a significant catalyst for boosting both motivation and engagement in educational settings (Zimmerman, 2008; Broadbent, 2021). Its benefits are manifold, ranging from fostering a learner-centred approach to providing immediate, meaningful feedback, all contributing to the realisation of engaged, self-regulated learning (Nicol, 2009; Y1Feedback Report, 2012; Bennett et al., 2017; Blondeel et al., 2022). Einig (2013) reported that online formative assessments can positively influence both student motivation and engagement. As discussed in the first benefit above, studies by authors such as Andrade (2019) and Clarke and Luna-Bazaldua (2021) showed that self-regulated learning is an important aspect of student learning. Online platforms extend avenues for immediate and continuous formative feedback. As indicated by Wolsey (2008), formative feedback empowers students to ascertain their strengths and weaknesses, thereby promoting revisions and ongoing refinement of understanding. This form of learning feedback promotes engaged, self-regulated learning. Additionally, Crisp and Ward (2008) affirmed that formative feedback can engender improved academic achievement and heightened motivation to learn. In a higher education context, Koh (2008) and Gikandi et al. (2011) highlighted similar benefits, including deep learning, increased motivation, bolstered self-esteem, and the promotion of self-regulated and transferable learning. Gikandi et al. (2011) pinpointed a recurring theme in the academic literature, which is

the capacity of online formative assessment to engage students in meaningful learning experiences, concluding that this is achieved through the construction of learning environments that encourage the active engagement of students, which is an essential precursor to meaningful learning.

Feedback Provision

Technological infrastructures have been instrumental in bolstering the efficiency of feedback provision. This is particularly beneficial for large cohorts of students where timely feedback can be challenging (Schaffer et al., 2017). Furthermore, technology-supported approaches can potentially expedite the delivery of a greater volume of timely feedback to large student bodies (Y1Feedback Report, 2016). This report also points out the risks inherent in this, which are outlined in Section 2.3.3 below. Emerging from the literature is the understanding that technology provides avenues for customised, diverse, and inclusive feedback strategies. Technology offers tailored feedback mechanisms by enabling adaptive learning platforms, automated feedback systems, and interactive tools that provide immediate, specific, and personalised responses to student performance (Henderson et al., 2019; Winstone & Carless, 2020). For instance, such systems can analyse individual student progress and generate targeted recommendations or highlight areas requiring improvement, aligning feedback with their unique learning needs (Dawson et al., 2019). Technology thus augments the repertoire of feedback formats and approaches, including opportunities for dialogic feedback facilitated through online discussion boards, peer assessment platforms, and real-time annotations (Y1Feedback Report, 2016, p. 35). These findings highlight the transformative potential of technology in enhancing feedback provision, offering more inclusive, adaptive, and accessible feedback opportunities that align closely with individual student needs.

Technology-mediated formative assessments offer instructors ongoing opportunities to monitor and discern patterns of strengths and weaknesses in student performance (Wolsey, 2008). This active monitoring enables educators to provide "concurrent, scaffolded interventions," that address identified learning gaps (Gikandi et al., 2011, p. 2342). Additionally, this technology-supported monitoring is pertinent in time-constrained online settings. Stokhof et al. (2017) emphasised that such monitoring should complement, rather than replace, individualised feedback. Online self-assessment quizzes have emerged as powerful tools for enhancing learner engagement.

They provide immediate feedback that allows students to self-assess, reflect, and adjust their learning strategies (Broadbent, 2021). The evidence suggests that frequent engagement with feedback correlates with improved performance in summative assessments (Gikandi et al., 2011, p. 2344). The integration of technology into the feedback loop affords several advantages including improved student engagement with feedback, greater flexibility and accessibility, as well as the provision of dialogic feedback opportunities (Y1Feedback Report, 2016, p. 35). These findings highlight the benefits of integrating technology into feedback processes, demonstrating its capacity to enhance engagement, improve accessibility, and support more effective learning outcomes through tailored and timely responses.

Academic Achievement

McCallum and Milner (2021) highlighted another fundamental benefit of TEFA, which is the elevation of student understanding, subsequently supporting deeper learning processes. However, they noted that the effectiveness of TEFA depends on the clarity, relevance, and actionable nature of the feedback it provides, as well as its integration into the broader learning context. Similarly, Walker et al. (2008) provided a more detailed perspective, emphasising the necessity of a deliberate role for formative e-assessments in nurturing deep learning. They stress that the quality of feedback and guidance provided to students is crucial to the impact of these assessments. Empirical evidence suggests that online quizzes employed as formative assessments have a positive bearing on summative exam performance. For example, Dobson (2008) concluded that formative online quizzes not only enhanced summative exam scores but also served as valid predictors of those performances (pp. 297, 300). This was echoed by Chung et al. (2006), as cited in Gikandi et al. (2011), who demonstrated how online formative feedback leads to academic improvement. They pointed to the immediate feedback aspect which enabled students to improve their performance in summative assessments. As Jump (2011, p. 65) noted, "success for the students involved in the case studies was more likely to be reported by improved satisfaction through the use of technology than improved learning, or changes in learning behavior." This suggests that while technology-enhanced assessments can enhance student satisfaction, their impact on actual learning and behavioural change may be less pronounced.

Other studies have noted something of a faltering at final stages of implementation. Jump (p. 65) further observed that many studies aim "to prove that structuring teaching

in this way would improve student learning or encourage a greater level of independence in learning by the students," yet the realisation of these aims is not always evident. In this vein, Kirkwood and Price (2013, p. 327) critiqued the application of technology in education, arguing that "few published accounts of TEL practices show evidence of a scholarly approach to university teaching. Frequently, TEL interventions appear to be technology-led rather than responding to identified teaching and learning issues." They advocated for a more scholarly approach among university teachers, emphasising that the "purpose of professional development activities is often ignored," and suggesting that enhancing pedagogical practices is more critical than providing mere technical training to maximise TEL effectiveness. Building on the recognition that robust pedagogical strategies outweigh mere technical proficiency in TEL, Walck-Shannon et al. (2019) extend this emphasis by advocating for semester-long, low-stakes testing opportunities designed to promote deeper learning through timely and substantive feedback. This aligns with the need for a more intentional and pedagogically sound approach to technology-enhanced assessments, as suggested by Kirkwood and Price (2013).

Monitoring Performance

Many studies stress the importance of continuous performance monitoring to foster ongoing academic improvement. Gikandi et al. (2011) stated that TEFAs contribute to the construction of learner-centric and assessment-focused environments "by providing opportunities for interaction with self," (p. 2344). They further noted how online platforms offer dynamic settings that enable instructors and students to collaboratively engage in the clarification of learning objectives, course content, and anticipated outcomes. They asserted that this collaborative space allows for the constant monitoring of progress towards achieving these academic aims. These collaborative spaces allow for constant monitoring of progress towards academic goals, which they argued is significantly enhanced by the affordances of technology. Such technology-based systems offer expansive opportunities for consistent monitoring, facilitating the identification of student strengths and weaknesses.

However, this is only part of the story. Gikandi et al. suggested that this allows for the provision of tailored formative feedback from both instructors and peers, aiming to bridge identified performance gaps. In addition, the technology serves as a medium for interaction with self, extending the boundaries of learning beyond traditional formats.

It provides learners and educators with "flexible opportunities to document and annotate evidence of student growth and performance that allow ongoing monitoring of student progress and achievement by the teacher as well as the students themselves" (p. 2344).

Studies also highlight the significance of monitoring performance to ensure that teaching methods remain adaptive and effectively address learners' evolving needs. Malau-Aduli et al. (2014) discussed how online monitoring can improve quality assurance in the formative process and enable adaptive teaching. They observed that the analytic capabilities of technology also bring efficiency to the monitoring of performance metrics, while automatic generation of item performance data allows instructional staff to conveniently undertake quality assurance processes. They concluded that this automation informs educators about the advancement of student learning and empowers them to modify their teaching approaches for more effective learner support.

Building on these insights, Dawson et al. (2019) emphasised the role of data analytics in TEFA. They noted that digital tools provide educators with actionable insights into student performance. These analytics not only identify learning gaps but also enable educators to tailor interventions based on real-time data. Similarly, Ní Shé et al. (2023) highlighted the potential of monitoring technologies to enhance formative practices, particularly in mathematics education. They argued that technology can support consistent performance tracking and ensure students remain engaged with challenging material, offering new opportunities for early intervention. Krishnan (2023) extended this discussion, suggesting that TEFAs can promote self-regulated learning by making progress visible to students. They contended that this visibility fosters greater agency, as students can monitor their development and make informed adjustments to their learning strategies. Such tools also empower instructors to use real-time data to refine their instructional approaches, creating a feedback loop that benefits both parties. When considered simultaneously, the literature reviewed in this section indicates that continuous performance monitoring positively impacts student learning outcomes and also guides educators in adapting their teaching practices.

Flexibility and Equity

The integration of technology in formative assessment introduces a dimension of flexibility and equity, that is essential for a modern, inclusive educational environment. Online assessments, as highlighted by Einig (2013), are adaptable to individual learning

approaches and rhythms, allowing students to engage with assessments at their own pace, revisit them as needed, and receive immediate feedback. This approach is especially beneficial in addressing the diverse needs of learners. Bennett (2011) emphasised the convenience of CBAs in formative learning, offering students the freedom to choose the timing and setting for their assessments. Such flexibility not only caters to different learning approaches but also respects individual schedules and commitments. Moreover, these assessments provide a private space for students to identify and work on their weaknesses, enabling them to make mistakes and learn from them without the pressure of immediate exposure to assessors or peers, a concept supported by the research of (Winstone & Carless, 2020). This aspect of formative assessment through technology nurtures a learning environment where students can confidently explore and grow. As Gikandi et al. (2011) noted, this approach aligns with the current educational emphasis on inclusivity and equal opportunities, thus democratising the learning experience and making it more accessible and personalised. Nevertheless, this technologically enhanced educational paradigm is not without its challenges. Bennett et al. (2017) shed light on concerns raised by university lecturers regarding students' access to technology and their varying levels of digital proficiency. A notable reflection from the lecturers' perspective encapsulates this dilemma: "There's this assumption that the students are technologically savvy and they're actually not. So, the extent to which you can embed technology into the assessment is limited by the reality of students' existing technological proficiency" (Bennett et al., 2017, p. 677). This observation draws attention to the need for a balanced approach in integrating technology into assessment, considering the technical skills of the student body to avoid inadvertently creating barriers or a digital divide.

2.3.3. Challenges with the Use of Technology in Assessment

The integration of technology into educational assessment practices presents a double-edged sword: on one side the promise of innovation and improved learning, while on the other, simultaneously raising a range of challenges (Bennett et al., 2017; Kiersey et al., 2018). This section outlines key challenges and obstacles faced in integrating technology-enhanced assessments (TEAs) into higher education. It begins by addressing the cultural barriers inherent in traditional educational settings and explores the balance between embracing innovation and maintaining sound pedagogical practices. It then examines the variability in adoption rates, the importance of

institutional support, the tension between educator effort and potential efficiencies, and the quality and impact of feedback, which all add layers of complexity to this research domain.

Cultural Hurdles in a Traditional Educational Sector

In the higher education landscape, the marriage of technology with traditional assessment practices often elicits resistance or scepticism. Bennett et al. (2017) suggested that this reluctance may stem both from deeply entrenched institutional norms and individual dispositions towards technology. They also argued that educators and administrators may perceive the integration of technology into assessment as a risk, particularly in institutions where the broader culture is cautious about embracing pedagogical innovation. Even in earlier studies of technology-enhanced learning (TEL), Warburton (2009, p. 269), discussing UK studies from 1999 to 2004, reported that "cultural factors continue to matter more than operational influences." Therefore, creating a conducive environment for TEAs requires not only technological competence but also a broader cultural shift within educational institutions.

Bennett et al. (2017) observed that educators who integrate technology into assessment design need "bravery" (p. 679) to withstand potential criticism from students and colleagues. They noted that departing from established practice "may encourage conservatism in assessment design" if new tools are seen as risky (p. 673). This balance, they argued, often hinges on "the teacher's desire to 'do something new' and the broader institutional approach to technology in education," (p. 679), raising questions about whether current higher education contexts truly facilitate optimised technology-enhanced assessment initiatives. Such tensions reflect the broader "state of the actual" described by Selwyn et al. (2020), where institutional and cultural conservatism frequently hinder innovation, leaving educators constrained by existing norms. However, there are differing points of view in this regard. Fawns (2022), for example, suggested that resistance to change should not be viewed solely as individual reluctance, but as a reflection of the complicated interplay between technology, pedagogy, and institutional context. This view reframes the challenge as a systemic issue rather than one of individual hesitation, highlighting the need for a more entangled and holistic approach to technology integration.

Innovation Versus Pedagogy

The literature suggests that establishing an equilibrium between innovation and pedagogy is of paramount importance. In the quest for innovation, educational technologists and policymakers may inadvertently neglect the essence of what Bennett et al. (2017, p. 680) called "thoughtful assessment." The challenge lies in striking a balance between the "allure of the 'new,'" (Selwyn, 2012, p. 215) and the pedagogical validity of the "appropriate" and also "resist the temptation to unthinkingly associate digital technologies with inevitable change and progress" (p. 215). The research focus has largely been on early adopters and innovators, potentially alienating those who might offer significant pedagogical insight but are less technologically oriented. As a result, technological solutions are sometimes applied in a manner that is incongruent with educational best practices, thereby undermining the efficacy of the assessment (Kiersey et al., 2018). In a bid to safeguard against these pitfalls, the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2009), offered a structured model for integrating technology, pedagogy, and subject-specific knowledge. A more detailed exploration of TPACK's role in bridging the gap between pedagogy and technology is discussed in Chapter 3: Theoretical Framework. Similarly, Kennedy et al. (2015) emphasised the relationship between technology and education, particularly in the realm of online learning and technology-enhanced assessments. They draw attention to the time demands in designing, developing, and teaching online courses, suggesting that this time is "different from the time spent in traditional face-to-face teaching," (p. 177). Specifically, the authors noted that preparing online courses often requires a substantial upfront investment of time. Further illustrating these time demands, Kaya-Capocci et al. (2022) suggested this includes the creation of multimedia resources, the design of interactive activities, and the development of automated feedback systems. These tasks demand significant planning and technical expertise. Furthermore, maintaining these courses involves ongoing activities such as responding to student queries in asynchronous settings and regularly updating digital materials. These aspects contrast with the more immediate and real-time nature of face-to-face teaching, illustrating the distinct time demands of online course delivery. Kennedy et al. (2015) advocated for a comprehensive accounting of both teaching costs and learner benefits in educational decision-making, noting that failure to do so might lead to "ill-informed decisions about the future of education." (p. 194). Extending this discussion, Fawns' (2022) concept of entangled pedagogy questioned the separation of pedagogy

and technology. He argued that teaching methods, technologies, and educational contexts are deeply interconnected and influence each other. Instead of prioritising one over the other, Fawns suggested focusing on how these elements work together to support educational values and goals. These sources highlight how the incorporation of technology in assessment within higher education is a complex process, influenced by a multitude of factors. With a view to addressing these complexities, Bennett et al. (2017, p. 672) highlighted the importance of providing "pedagogical guidance and technical help at critical stages of the design process," advocating for "an iterative approach to design." This perspective is crucial, as it suggests a scaffolded and reflective practice in developing TEAs. In their study, Dawson et al. (2013) examined the complexities of assessment design, revealing that decision-making "occurs at multiple levels, and is influenced by expertise, trust, culture, and policy," (p. 107). These layers of influence highlight the complexity of integrating technology into routine assessment practices. Bennett et al. (2017, p. 674) provided similar insight into the integration process, observing how university teachers incorporate technology into their assessment strategies and the consequential impact on their design choices.

The perception of technology-supported assessment as a modern and innovative practice is another crucial aspect of its adoption (Kennedy and Dunn, 2018). The enthusiasm for technology as a contemporary approach is palpable among educators, with many viewing it as an inevitable progression in the educational landscape (Gaebel et al., 2021). However, this progression is not without its challenges. Research indicates that educators' rationale for adopting technology is sometimes shaped more by the available tools than by pedagogical considerations, potentially leading to a misalignment between technology and learning goals (Kennedy & Dunn, 2018; Zhang, 2022). Bennett et al. (p. 676) highlighted this tension, observing that "the rationale for using technology is often influenced more by what tools are available rather than by the aim of pedagogical improvement." This disconnect stresses the need for integrating technology in ways that complement sound pedagogical principles (Polly et al., 2021).

Responding to this need, Marín et al. (2020) highlighted the co-constructed nature of assessment design, emphasising how the interplay among institutional culture, disciplinary norms, and technology shapes the effectiveness of technology-enhanced assessments. Similarly, Kennedy and Dunn (2018) drew attention to the multilayered relationship between educators and technology, noting that the integration process is

influenced by both the opportunities and limitations presented by technological tools. While the allure of "cutting-edge" technologies often inspires educators to innovate and take risks, Bennett et al. (p. 679) described this as the "romance" with technology, where the appeal of novelty may sometimes overshadow practical considerations. Practical challenges arise when these tools fail to align with educational objectives, as demonstrated in recent analyses of institutional practices (Ní Shé et al., 2023).

The literature emphasises that technological tools, when integrated effectively, can play a significant role in achieving the pedagogical goals of formative assessment. However, the choice of technology is a critical factor and it is imperative that the chosen technology aligns with specific educational objectives, rather than being influenced solely by the novelty or even the sophistication of the tool (Wiliam, 2011). Previous research shows the need for tools to complement constructivist approaches to pedagogy, which prioritise active learning and student engagement through TEFAs (Clark, 2012). This perspective points to the importance of integrating technology thoughtfully to enhance educational outcomes while avoiding a mismatch between the technological solution and pedagogical intent.

Inconsistent Adoption and the State of the Actual

In the realm of higher education, the adoption of technology in assessment practices has been notably inconsistent (Venkatesh & Davis, 2000). This phenomenon, described by Selwyn (2008, 2012) as the "state of the actual," encapsulates the many challenges and facilitators that influence the widespread application of TEAs. Bennett et al. (2017) also discussed how the "state of the actual" is characterised by a complex mix of elements including technological infrastructure, educator proficiency with digital tools, and student readiness. Collectively, these elements contribute to variances in the adoption of TEAs and hinder the establishment of a uniform approach across various educational environments. More recently, Gaebel et al. (2021) have highlighted persistent disparities in the adoption of digital tools across European higher education institutions, citing differences in institutional capacity, resource allocation, and strategic vision. Zhang (2022) similarly pointed to variability in adoption. She noted that institutional priorities often diverge from pedagogical needs, thereby creating barriers to effective implementation of technology-supported assessments. These recent findings demonstrate that the challenges identified in earlier works remain highly relevant in contemporary settings.

Unfortunately, identifying the problem does not always equate to understanding the problem. As Bennett et al. (2017, p. 673) acknowledged, the reasons behind this limited adoption are not well-understood, indicating a gap in research that necessitates "further scholarly investigation." Additionally, they noted that despite the potential advantages of technology tools in enhancing assessment processes, their uptake has been erratic (p. 673). Implementing technology-supported assessment is not merely about the adoption of tools; it demands substantial support and often requires compromises (p. 678). Recent studies by Polly et al. (2021) reinforced this point, identifying inadequate technical support and lack of faculty training as persistent barriers to adoption. The inconsistency in adoption is further complicated by the pressures of increasing university enrolments, which demand both efficiency in assessing large cohorts and the maintenance of quality education (Bennett et al., 2017, pp. 678–679). Given these complexities, ensuring meaningful integration of technology in assessment calls for a strategic approach that balances operational demands with the preservation of educational quality. While technology offers solutions such as reduced marking time and automated feedback, it also poses challenges that must be navigated. Gaebel et al. (2021) noted that these challenges are often amplified in under-resourced institutions, where the infrastructure required to support scalable technology-enhanced assessments is lacking. Ní Shé et al. (2023) further pointed out that cultural resistance within institutions can hinder progress, especially in traditional disciplines that favour established assessment methods. Bennett et al. (2017, pp. 680–681) suggested that research into the "state of the actual," in technology-supported assessment should investigate teaching practices across different institutional contexts to uncover new issues or varying emphases. Selwyn (2012, pp. 216–217) cautioned against being captivated by the novelty of digital technology, urging researchers to consider the present complexities and not just the potentialities of the "state-of-the-art." He emphasised the importance of focusing on what actually happens when technology is introduced into the classroom, the "state-of-the-actual," (Selwyn, 2008, p. 83), and to be aware of the ongoing patterns and challenges that persist with the use of new technologies in education. Overall, these studies illustrate that consistent and meaningful adoption of TEAs relies on a blend of context-specific strategies, pedagogical integrity, and crucially, ongoing institutional support.

Importance of Institutional Support

Building on this emphasis on institutional support, it is clear that the successful deployment of TEAs depends on more than just policy directives or funding. Effective institutional support encompasses training, professional development, and a culture that values innovation in teaching and learning. Without such comprehensive support, even the most advanced TEAs risk underperforming (Bass, 2012). Additionally, a lack of alignment between institutional priorities and practical implementation can lead to wasted investments and diminished outcomes (Bennett et al., 2017). These observations highlight the essential role of institutions in facilitating the effective use of TEAs, a point further supported by the literature that follows.

Bass (2012) argued that for an initiative such as e-portfolios, which can be considered part of broader TEA initiatives, to succeed, it must address four critical areas: institutional needs and support, connections across departments, faculty involvement, and student success. He suggested these initiatives should be viewed through multiple lenses, such as technology, outcome assessment, social pedagogy, and strategic planning. This comprehensive approach emphasises the importance of institutional alignment in the successful implementation of TEAs. Yet, Bennett et al. (2017) found that barriers and enablers in adopting TEAs are often context-dependent, with varying resources, institutional priorities, and discipline-specific needs making a one-size-fits-all approach impractical. They also highlighted "mixed messages within institutions and the demands of design work" (p. 672), revealing a disconnect between institutional goals and the actual implementation of TEAs. Such misalignment can impede effective use of technology in assessment, resulting in inconsistent or incomplete adoption.

To overcome these challenges, institutional backing must extend beyond policy statements and financial investment. King and Boyatt (2015) along with Harrison et al. (2016) emphasised the need for systemic change, including infrastructure upgrades and robust professional development for staff. By fostering a culture of continuous learning, institutions equip educators with the skills and confidence needed to integrate technology effectively, thereby maximising the impact of TEAs on student learning outcomes. As both Bass (2012) and Bennett et al. (2017) have argued, adopting a multifaceted strategy that addresses technological, pedagogical, and strategic considerations creates fertile ground for innovation. This alignment is pivotal to

overcoming institutional inertia and ensuring that TEAs are not only implemented but also capable of driving meaningful improvements in student engagement and success.

Educator Effort Versus Efficiencies

Striking a balance between the heightened workload required for implementing TEAs and the promise of increased efficiency remains an ongoing challenge in higher education. Kiersey et al. (2018, p. 25) stressed the necessity of "appropriate allocations of time to facilitate TEA," encompassing setup, implementation, training, and ongoing maintenance. This emphasis highlights a core tension in TEAs, which is, while they hold potential efficiencies for educators in the long run, their initial implementation can be labour-intensive. Educators must familiarise themselves with new technologies, build resource banks (such as question sets), and support students as they adapt to these systems (Blair et al., 2016; Kiersey et al., 2018). Despite the prospects for streamlining assessment processes, the substantial workload associated with the setup phase can be overwhelming, prompting some educators to revert to traditional methods (Bennett et al., 2017).

Kiersey et al. (2018, p. 9) advocated for well-structured tasks that scaffold learning and can "free class time and enhance the ability of staff to foster collaborative learning." Yet, they also identified "the increased workload involved in the initial stages of implementing TEAs" as a significant concern (p. 9). The time devoted to creating comprehensive question banks and ensuring students' familiarity with TEAs can be considerable, though it gradually shifts to less intensive maintenance efforts, which is an ongoing requirement that still contributes to educators' workloads.

The "economics of assessment," as Bennett et al. (2017, p. 675) described it, demonstrates the pressure to adopt more efficient forms of assessment, particularly in large classes where online quizzes can offer immediate feedback and reduce marking demands. Nonetheless, Bennett et al. cautioned that pursuing labour-saving technologies could have unintended outcomes if adopted without sufficient foresight or experience, reflecting a broader tension between efficiency and innovative pedagogy. Likewise, Kiersey et al. (2018, p. 25) stressed the need for "appropriate allocations of time to facilitate TEA," noting that the initial workload in creating question banks and familiarising students with new tools can be substantial. While they advocated for well-structured tasks that might "free class time" (p. 9), they also emphasised that upfront preparation and ongoing maintenance continue to add to educators' responsibilities.

Warburton (2009, p. 269) further revealed the long-standing challenge of cost, both "in terms of personal time and the expense associated with computer-assisted assessment software and infrastructure," suggesting that these financial and temporal constraints remain key barriers to widespread TEA adoption.

In light of these perspectives, it is evident that although TEAs have the potential to offer long-term efficiencies for educators, the substantial initial time and effort required for their implementation remains a significant obstacle. This is particularly topic these days given the "time-poor" nature of academic staff (Bennett et al., 2017, p. 679). This challenge suggests the need for a reconsideration of workload distribution, with a focus on dedicating more time to assessment design and the provision of formative feedback, rather than solely relying on traditional content delivery (Bennett et al., 2017, p. 680). Moreover, economic constraints and institutional pressures often dictate which assessment technologies are adopted, further shaping the trajectory and feasibility of TEA integration. As such, finding a balance between pedagogical innovation and institutional limitations continues to be a critical factor in the adoption of TEAs.

Feedback: Quality and Impact

As discussed previously, the provision of feedback through TEAs stands as a critical aspect of educational practice, with its quality and impact under constant evaluation. The effectiveness of any assessment mechanism is gauged not only by its evaluative capacity but also by the feedback it generates, which should ideally contribute constructively to students' learning processes. In the context of TEAs, the challenge intensifies as feedback mechanisms facilitated by technology demand rigorous scrutiny to ensure they hold pedagogical value and positively affect student engagement and learning outcomes (Maier et al., 2016). Pivotal studies by scholars such as Nicol (2010), along with insights from the Y1Feedback Report (2016), all point to the recognised potential of feedback in the learning cycle. However, there appears to be a disconnect between the theoretical advantages of timely feedback and its actual delivery in the educational setting. This gap is highlighted by findings from the Irish Survey of Student Engagement 2014-2021 (NicFhlannchadha, 2022), which reported that a considerable number of students do not receive feedback of any kind in a timely manner. Moreover, Kiersey et al. (2018) suggested that there seems to be a dearth of robust research focusing on the experiences of staff in implementing TEAs and the quality of feedback that results from these digital assessments. The authors concluded that the reality of

feedback practices within educational settings often falls short of its potential. They posited that the delay in providing feedback is a significant issue, as it can diminish the feedback's relevance and usefulness to students who require timely responses to assimilate and apply the insights to their learning.

Despite the acknowledged potential for technology to refine and enhance feedback mechanisms, empirical research specifically evaluating the real-world impact of these technologies, particularly within Irish educational institutions, remains limited (NFETL, 2017). This report highlighted that there is a scarcity of such studies, suggesting that there is an opportunity for in-depth exploration into how TEAs are shaping feedback quality and the extent to which this feedback influences student learning.

Critical Perspectives on Technological Determinism

While much of the literature on technology-enhanced learning (TEL) focuses on its pedagogical benefits, such as immediacy, scalability, and accessibility, critical scholars argue that the relationship between digital technology and education is inherently political, economic, and ideological (Selwyn, 2015). Educational technology frequently appears in policy discourse as a self-evidently progressive innovation, a stance that can marginalise legitimate questions around equity, agency, and power (Selwyn, 2015; Watters, 2019). This perspective is crucial given that digital technologies are often implemented without sufficient interrogation of their underlying assumptions or intended outcomes, a phenomenon Selwyn (Selwyn, 2015, p.303) characterises as "technological 'boosterism'," where the enthusiastic promotion of technology can obscure complex and sometimes problematic realities.

Selwyn (2015) calls for a sustained critical approach that acknowledges educational technology's entanglement with broader socio-political structures, notably neoliberal policies that promote efficiency, accountability, and commodification within higher education. This ideological context fosters market-driven narratives around education as a private good rather than a public responsibility (Selwyn, 2015; Watters, 2019). Digital tools often support and reinforce these ideologies through processes of standardisation, automation, and datafication, reflecting corporate interests rather than pedagogical or learner-centred priorities.

Watters (2019) echoes this critical view, providing evidence of how ed-tech interventions often reflect venture capital-driven models prioritising market growth and

return on investment over genuine educational improvement. She argued that substantial investment in ed-tech has often been disconnected from robust empirical evidence of pedagogical effectiveness, driven instead by narratives of inevitable technological disruption. Similarly, Kirkwood and Price (2014) have raised critical questions about what precisely is meant by 'enhancement' in TEL interventions, arguing that too often enhancements are presumed rather than rigorously demonstrated. Their analysis found that TEL research frequently focuses on operational or quantitative improvements, such as increased flexibility or improved test scores, without adequately demonstrating meaningful qualitative enhancements to student learning.

This disconnect between policy rhetoric and classroom reality is echoed across multiple levels of the Irish education system. In schools, McGarr (2009) found that despite successive national ICT initiatives, technology use remained largely confined to discrete informatics subjects, shaped more by local school cultures and teacher beliefs than by policy directives. In Further Education and Training (FET), Ryan et al., (2020) identified a phenomenon of "techno-positivity" among teachers, where positive attitudes toward technology masked limited or conservative use. Their study also revealed "techno-guilt," where teachers blamed themselves for not using newer technologies, even when systemic barriers were at play. These findings highlight how dominant discourses can obscure the complex realities of technology integration and contribute to the de-professionalisation of educators. A similar pattern is evident in the Irish higher education context, where initiatives such as the Digital Learning Framework (DLF) also reflect an uncritical techno-positivity that may overlook genuine pedagogical complexity and the diverse needs of educators and learners (Cooney et al., 2023). Cooney et al. (2023) found that while the DLF promoted a vision of seamless digital integration, the actual enactment at the school level revealed significant disconnects, with teachers navigating time constraints, under-resourced roles, and superficial pedagogical shifts that did not always translate into meaningful learning improvements. This reinforces the broader critique that techno-positive policy rhetoric often obscures the on-the-ground realities of implementation. As Ní Shé et al. (2023) demonstrated, the rapid immersion in digital learning due to crises such as COVID-19 highlighted substantial gaps between institutional assumptions of 'digital readiness' and the realities faced by students and faculty, revealing the risks of techno-determinism.

Consequently, this study positioned technology not simply as a neutral tool, but as a contested space where pedagogical practices, institutional policies, and ideological influences intersect. The study critically examined not only how TEFAs might positively influence learning, but also how they could inadvertently perpetuate inequalities or reinforce narrow conceptions of learning. By aligning with the critical insights cited above, this research questions deterministic assumptions that portray educational technology as inherently transformative. Instead, it advocates for a context-sensitive, critically reflective approach.

In doing so, it contributes to wider discussions on the responsible and ethically informed adoption of educational technologies in higher education and supports the call by Ryan et al., (2020) for a new dialogue that moves beyond binary pro/anti-technology positions and instead empowers educators to critically evaluate the role of technology in their specific contexts.

2.3.4. Research Gaps in Technology Enhanced Learning

Research into Technology Enhanced Learning (TEL) and its application in higher education presents a complex picture, with several researchers highlighting significant gaps and raising critical concerns about the field's coherence and rigour (Kiersey et al., 2018). Those researchers observed that, as the landscape of higher education evolves, the integration of technology into learning and assessment processes remains a pivotal yet challenging endeavour.

Kiersey et al. (2018) conducted a comprehensive systematic literature review of 252 studies that examined technology-enhanced Assessment OF, FOR, and AS Learning, with a particular focus on the experiences of staff. They found that while there is an abundance of insight into the practices of early adopters, there is a conspicuous absence of extended, longitudinal studies. The review called for more robust, empirical, and comparative research to inform sound assessment practices and to ascertain whether the current higher education environment truly supports optimised TEA practices. The authors highlighted a striking scarcity of high-quality, peer-reviewed research centred on staff experiences with TEA, noting that the existing literature is predominantly student-focused. Moreover, they suggested that the limited longitudinal scope of these studies restricts a comprehensive response to the research questions at hand, leading to calls for further investigation into the long-term application and implications of TEA (p. 6). This indicates that extended and more rigorous inquiry is essential to fully

understand how TEAs can shape teaching practices, staff experiences, and long-term educational outcomes.

Extending this concern to the broader field of educational technology, Selwyn (2012) offered a critical lens on the state of education and technology research, denouncing it as an incoherent field plagued by a lack of sustained academic focus. This concern remains relevant, as Selwyn et al. (2020) argued that EdTech research continues to grapple with fragmented priorities, compounded by growing corporate influence and systemic inequities. They depicted it as a transient collection of individuals from disparate disciplines, each with their own agendas and interests, resulting in a fragmented and underdeveloped body of knowledge. Selwyn's (2012, p.213) pointed out that criticism encapsulated the field as a "mongrel" area of scholarship, overrun with substandard investigations and characterised by a plethora of standalone case studies and dubious theoretical contributions. This sentiment was echoed by Gaebel et al. (2021), who highlighted the fragmented implementation of digital learning tools across European higher education, revealing disparities in institutional strategies and resources. Similarly, Zhang (2022) identified misalignments between strategic goals and practical implementation, often leading to suboptimal adoption of assessment technologies. Polly et al. (2021) emphasised that a lack of sufficient pedagogical and technical support remains a significant barrier for academic staff, complicating efforts to integrate technology effectively. These challenges illustrate the critical need for institutions to provide substantial and ongoing support at key stages of assessment design, ensuring that strategies can be refined and sustained.

Scope, Rigour and Specificity

The domain of TEAs is marked by significant gaps in both scope and rigour, with issues around the reliability and validity of these assessments persisting, largely unaddressed (Kiersey et al., 2018). Bennett et al. (2017, p. 672) stated, "a wide range of technologies has been developed to enhance assessment, but adoption has been inconsistent." This inconsistency reflects the complexity and challenges that academic staff face in designing and implementing technology-supported assessment strategies, where the intent is often torn between the pursuit of "greater efficiencies," and the desire to be "contemporary and innovative" (p. 672). The dearth of longitudinal research in this area restricts our ability to ascertain the long-term implications and efficacy of TEAs, a concern highlighted by multiple scholars (Blair et al., 2016; Çakıroğlu et al., 2016).

Bennett et al. (2017, p. 681) argued for a more in-depth exploration, suggesting that "a more detailed study of actual practice that traces the development of new assessments from the proposal stage through multiple iterations would be time-consuming but extremely valuable." Despite the expansion of research into TEAs, studies typically exhibit a narrow focus and fail to capture the broader implications of technology on the assessment process. The literature's current trajectory suggests a critical mass of empirical evidence is yet to be achieved, which inhibits the ability to formulate generalisable conclusions (Kiersey et al., 2018). Bennett et al. (2017, p. 680) acknowledged this, emphasising the need to "do more to support academics in reflecting on the effectiveness of their designs, both during and after the teaching, [which] would benefit technology-supported assessment designs in future iterations." Hence, a broader, longitudinal approach is needed to fully capture the complexities and long-term impacts of TEAs in diverse educational contexts.

The experiences of staff during TEA implementation are notably underrepresented in the literature. Most existing studies provide only a glimpse into the early-stage implementation of TEAs, which limits the breadth of understanding that can be gained from such research. Bennett et al. (2017, p. 672) stressed the importance of this focus, stating that "we need to explore the perspectives of academics responsible for designing and implementing technology-supported assessment strategies." Another issue relates to educators not taking the adequate time needed to refine these strategies gradually over multiple semesters. As Bennett et al. (2017, p. 680) put it, "assessment designs supported by technology were often adapted or abandoned in the next iteration of a unit." This highlights the necessity for strategies that promote sustained and effective assessment designs. The authors further suggest that "approaching assessment design as a process of formative development over multiple iterations could be greatly beneficial" (p. 680).

In the context of specific disciplines, such as technology modules within business and accounting programmes, much of the literature acknowledges the potential benefits of online formative assessment and technology-supported feedback. However, studies like those by Bennett et al. (2017) indicate that a gap remains between the theoretical potential of these tools and their practical application. They argue that empirical research is needed to assess the actual impact of these practices on student learning outcomes, particularly within specific educational contexts. Bennett et al. (2017)

encapsulated this need for specificity, suggesting that "further research in technology-supported assessment could also specifically target the needs of those with pedagogical concerns who want the most appropriate technological solutions, rather than the most innovative," (p. 681).

Taken together, these findings highlight the urgency of bridging theoretical promise and practical implementation. This is an area that future research must address in order to realise the full potential of TEAs for improving teaching and learning.

Transition to Higher Ed

The transition from secondary to higher education is a complex and challenging process. Fisher et al. (2011) noted that this shift, described by Blondeel et al. (2023, p. 3) as a "stressful and life-changing event," often results in increased anxiety and reduced confidence in first-year students, particularly in specialised fields like accounting (Vanstone & Hicks, 2019; Blondeel et al., 2023). Within this context, the role of TEFAs in easing this transition emerged as a key area of interest because of the potential of TEFAs to help students identify gaps in their understanding and build confidence, as alluded to in the Y1Feedback Report (2016). Yet, this review of the literature has revealed that there is a significant gap in empirical research exploring the impact of TEFAs on this transitional experience. One prominent challenge during this phase is the heightened "lack of confidence and higher anxiety," that many first-year students face (Blondeel et al., 2023, p. 3). TEFAs offer the potential to provide real-time, personalised feedback, which could alleviate "students' concerns and anxiety around their abilities" (p. 5). Given that self-efficacy is closely "linked to anxiety about tests," TEFAs may provide the necessary support to stabilise this psychological aspect during the critical first year (p. 3). Therefore, the potential of TEFAs to mitigate transition-related anxieties, highlights the urgent need for deeper investigation into their real-world application and effectiveness.

Despite these promising benefits, rigorous empirical evidence remains limited. The Y1Feedback Report (2016, p. 7) indicated that while students value feedback, they are often dissatisfied with its "timeliness, consistency, clarity, and usefulness." This situation highlights the pressing need for comprehensive research into the effectiveness of TEFAs, which could potentially transform the feedback landscape. Additionally, there is a noticeable gap in studies addressing the experiences of faculty members in implementing TEFAs, revealing a broader, multi-dimensional need for further

investigation. Additionally, existing policy frameworks in Ireland such as the *Higher Education Strategy Group: Ireland's National Strategy for Higher Education to 2030* (DES, 2011) and reports by the Higher Education Authority (HEA, 2015) have stressed the urgency of improving student transition into higher education. Yet, the "disconnect between the potential of feedback, and feedback in practice," emphasises the need for more research into how technology, specifically TEFAs, can be integrated into these strategies (Y1Feedback Report, 2016, p. 7).

Students' prior experiences with assessment play a critical role in shaping their perceptions and engagement with OFAs. A history of high-stakes, summative assessment environments can predispose students to perceive assessments as evaluative rather than developmental (Stiggins, 2002). This perception can undermine the formative purpose of OFAs, which is to support learning through ongoing feedback and reflection (Sadler, 1989). Contemporary literature emphasises the need to reorient students' assessment experiences towards a growth mindset, where the focus is on learning progression rather than judgement (e.g., Dweck, 2007). This shift requires explicit instruction on the purpose and process of OFAs, as well as skill development in self-assessment and peer-assessment skills, which are foundational to leveraging OFAs for learning (Nicol & MacFarlane-Dick, 2006).

2.4. Gap in the Literature

This literature review has critically examined the existing research on three major components of this study: formative assessment, feedback, and the integration of technology in formative assessment. Numerous studies highlight the benefits and challenges associated with formative assessment, emphasising its role in improving student learning and engagement. Feedback, a critical element of formative assessment, has been explored extensively, particularly its impact on fostering self-regulation and guiding students' learning progress. Moreover, the review demonstrates the transformative potential of TEFA, particularly in creating more personalised and scalable assessments. However, significant gaps remain in the current research landscape.

Some of these gaps remain owing to the nature of studies involved. While the literature acknowledges the advantages of formative assessment and its contribution to enhancing learning, for example, there is a lack of comprehensive empirical studies that provide a longitudinal analysis of its long-term impact, particularly in the context of higher

education (Bennett et al., 2017; Kiersey et al., 2018). The review identified that much of the current research is either based on short-term studies or focused on early adopters, leaving a gap in understanding how these practices evolve over time, and how sustained formative assessment impacts both student outcomes and teacher practices (Broadbent et al., 2021). This gap is particularly pronounced in studies that explore the effects of technology-enhanced formative assessment on student engagement and learning outcomes in various disciplinary contexts. Additionally, while feedback has been recognised as integral to the success of formative assessment, much of the research remains student-centric, with limited focus on the experiences and challenges faced by educators in delivering high-quality formative feedback, particularly in technology-mediated environments (Gikandi et al., 2011; McCallum and Milner, 2021). The gap in understanding how educators navigate these challenges, especially in large classes or resource-constrained settings, highlights the need for further investigation into how institutional support and technological infrastructure can aid the implementation of effective feedback practices.

The other gaps that remain appear as a by-product of how we understand the role of technology, both in education and society more broadly speaking. While technology is recognised as a tool that can enhance formative assessment, particularly in scaling feedback and supporting self-regulated learning, for instance, significant challenges remain. Studies have highlighted concerns regarding the depersonalisation of feedback, digital literacy disparities, and the considerable time investment required for educators to develop and maintain technology-enhanced assessments (Bennett et al., 2017; Nicol, 2021) These challenges, along with ethical considerations related to data privacy and the accessibility of digital tools, necessitate further research into how institutions can better support educators and students in navigating these obstacles. While the potential benefits of TEFAs are widely acknowledged, there is a clear need for more comprehensive empirical studies that examine the long-term effects of these practices. This study aims to contribute to the existing body of knowledge by focusing on how TEFAs influence student engagement and learning in a third-level educational institution in Ireland, addressing the need for more context-specific research that considers both student and educator experiences. By doing so, it seeks to fill an important gap in the literature on how to effectively implement and sustain TEFA practices in diverse educational contexts.

Chapter 3: Theoretical Framework

This chapter presents the theoretical frameworks that underpin this study, providing essential background and context on the thinking that shapes the research approach. By aligning with established frameworks, namely Learning-Oriented Assessment (LOA) by Carless et al. (2006) and Technological Pedagogical Content Knowledge (TPACK) by Koehler and Mishra (2009), this chapter contributes to the understanding of TEL and assessment in higher education.

The LOA framework serves as the philosophical foundation of the study, providing a lens through which to examine the dynamics of formative assessment. Particular attention is paid to feedback, student-centred learning, and the dual function of assessment in both evaluation and education. Building on LOA, the TPACK framework offers a model that deepens the study's focus on formative assessment by emphasising the integration of technology with pedagogical and content knowledge, essential for designing and delivering content in digitally enhanced educational settings. While each of these frameworks is valuable individually, they also have limitations that may not fully address the specific needs of this study. For example, LOA's focus on formative assessment benefits from TPACK's guidance on technology integration, while TPACK's emphasis on technology, pedagogy, and content gains strength from LOA's attention to feedback and student engagement. Therefore, by combining these frameworks, this study aims to overcome their individual limitations and develop a more comprehensive understanding of the phenomena under investigation. This synthesis has led to the development of a customised, synthesised theoretical framework, uniquely suited to address the research objectives.

The following is an overview of this chapter. In Section 3.1, I clarify the concept and role of a theoretical framework, explaining how it guides every aspect of the research design. In Section 3.2, I review in detail the two core frameworks underpinning this study: Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK). I explore their historical developments, key principles, and limitations, especially in the context of technology-enhanced learning environments. Finally, in Section3.3, I describe my own customised theoretical framework, which synthesises LOA and TPACK principles to address the needs of this specific research. This integrated model will serve as the guiding structure for designing, implementing,

and evaluating the technology-enhanced formative assessments investigated in subsequent chapters.

3.1. Defining the Theoretical Framework

A theoretical framework provides the foundation for a study, guiding each stage of the research process and ensuring alignment between objectives, methodology, and interpretation of findings. For this study, the theoretical framework combines LOA and TPACK, both chosen to deepen our understanding of technology-enhanced formative assessment and its impact on student engagement in higher education. This framework is informed by on Eisenhart's (1991) concept of a theoretical framework as a structured guide rooted in coherent, established theories. Here, LOA and TPACK are synthesised to provide a tailored lens that examines the dynamic interactions between technology, pedagogy, and formative assessment.

As Grant and Osanloo (2014) describe, a theoretical framework is central to understanding and researching a topic effectively; it shapes everything from the formulation of research questions to methodological choices. For this research, the selection of LOA and TPACK not only defines the research problem but also justifies the questions asked and the methods chosen to answer them. By combining perspectives from both frameworks, this study aims to capture a holistic view of the phenomenon under investigation. The LOA component grounds the focus on formative assessment and feedback, while TPACK addresses the integration of technology into these practices.

In this study, the theoretical framework functions as both a philosophical foundation and a methodological guide, providing clarity and direction throughout. This dual framework allows the study to navigate the complexities of multiple data sources and perspectives, as well as to integrate findings in a coherent and meaningful way. As Sarter (2006, p. 494) cautions, without a justified theoretical framework, researchers risk the “limited usefulness of findings and conclusions.” The combination of LOA and TPACK aligns this study with the changing needs of technology-enhanced education, where effective assessment strategies play an increasingly pivotal role. In this landscape, placing students at the centre of the learning process, as Taras (2002) suggests, supports not only academic growth but also the development of lifelong learning skills. The synthesised framework development in this research provides but

one example of how educators can adapt to the demands of this rapidly shifting landscape.

3.2. Review of Key Theories and Models for this Study

This section reviews, in detail, the foundational theories guiding this research. Each framework brings distinct strengths, with LOA focused on feedback, formative assessment, and student-centred learning, and TPACK centred on effectively integrating technology into pedagogical practice. Together, these models provide a comprehensive basis for exploring technology-enhanced assessment. Before introducing the customised framework developed specifically for this study in Section 3.3, the next two sections examine LOA and TPACK, establishing a rationale for their combined application and addressing key principles, practical implications, and limitations of each.

3.2.1. Learning-Oriented Assessment (LOA)

This section examines Learning-Oriented Assessment (LOA), exploring its historical development, key principles, and relevance to formative assessment and student engagement. Central to this discussion is the scholarship of David Carless (Carless et al., 2006; Keppell & Carless, 2006; Carless, 2007, 2015), whose work on assessment in higher education is foundational in both its breadth and depth. Carless (2007) rigorously examines the complex landscape of assessment, celebrating its advancements at the time, such as diversified methods and greater transparency, while also casting a critical eye on enduring challenges like ineffective feedback mechanisms and a lack of innovation. Carless's (2007) development of what Boud (2000) referred to as the concept of "double duty" is particularly relevant, because it captures the dual roles that assessment plays in both evaluating and educating students. This concept highlights the tensions inherent in balancing these dual functions, revealing the complexities that educators navigate. This is especially challenging when institutional priorities do not always align with pedagogical effectiveness, emphasising the necessity of innovation in contemporary higher education settings.

3.2.1.1. Defining and Visualising LOA

As discussed, LOA emphasises the role of assessment as a tool for promoting and understanding student learning, rather than solely as a measure of academic performance (Carless, et al., 2006). It views assessment as a continuous process that shapes the learning journey, which aligns with this study's research questions and the

iterative nature of action research. This perspective is particularly significant in creating meaningful and effective learning experiences in technology-enhanced environments. LOA shifts the focus from traditional assessment practices, which often centre on measurement and grading, to a more holistic approach that considers both learning processes and outcomes (Carless, 2007, 2009). This study integrates diverse assessment strategies, specifically Assessment for Learning (AfL) and Assessment of Learning (AoL), within the LOA framework. AfL, which is characterised by its formative nature, focuses on feedback and activities that support ongoing learning (Black and Wiliam, 1998a). In contrast, AoL, often summative, evaluates learning outcomes at the end of an instructional period (Biggs, 1996). As outlined in Chapter 2, understanding the distinctions and complementary roles of these assessment types is vital for designing educational experiences that are both evaluative and conducive to learning (Yorke, 2003; Shepard, 2008).

Alongside AfL and AoL, this study also draws on the concept of Assessment as Learning (AaL), which positions students not only as recipients of feedback but as active participants in the assessment process itself (Earl, 2003; Dann, 2014; Lam, 2016). AaL emphasises student reflection, self-monitoring, and metacognitive awareness, thereby strengthening learner agency and supporting the development of self-regulation skills (Lam, 2016). While AfL primarily focuses on improving learning through teacher-guided feedback, AaL foregrounds the student's role in assessing their own progress and using assessment as a tool for learning (Dann, 2014). This conceptual distinction becomes particularly relevant in technology-enhanced environments, where digital tools can support self-paced reflection, personalised feedback, and independent goal setting. AaL, as Lam, (2016) notes, is especially powerful in portfolio-based and feedback-rich environments, where students engage in self-assessment and self-reflection to monitor their learning and revise their work. The role of AaL in the overall Learning-Oriented Assessment model is further illustrated in the middle layer of the customised framework presented in Section 3.3.

Building on these definitions, LOA effectively integrates AfL and AoL, leveraging their respective strengths. AfL's formative focus complements LOA's emphasis on feedback and ongoing learning, while AoL provides a summative perspective, assessing cumulative learning outcomes. This integration is key to addressing the research questions, shaping the methodological approach, and informing the selection of data

collection methods, analysis techniques, and interpretation of findings. Moreover, the integration of LOA, AfL and AoL principles provides a comprehensive lens through which the data can be examined, ensuring that the research outcomes are well-founded, relevant, and applicable to the field of educational technology. Within the context of an action research paradigm, the LOA framework offers the conceptual clarity necessary to define key variables and constructs related to assessment and learning. Additionally, this framework allows for an interdisciplinary approach, seamlessly incorporating insights from educational technology, pedagogical theories, and higher education research.

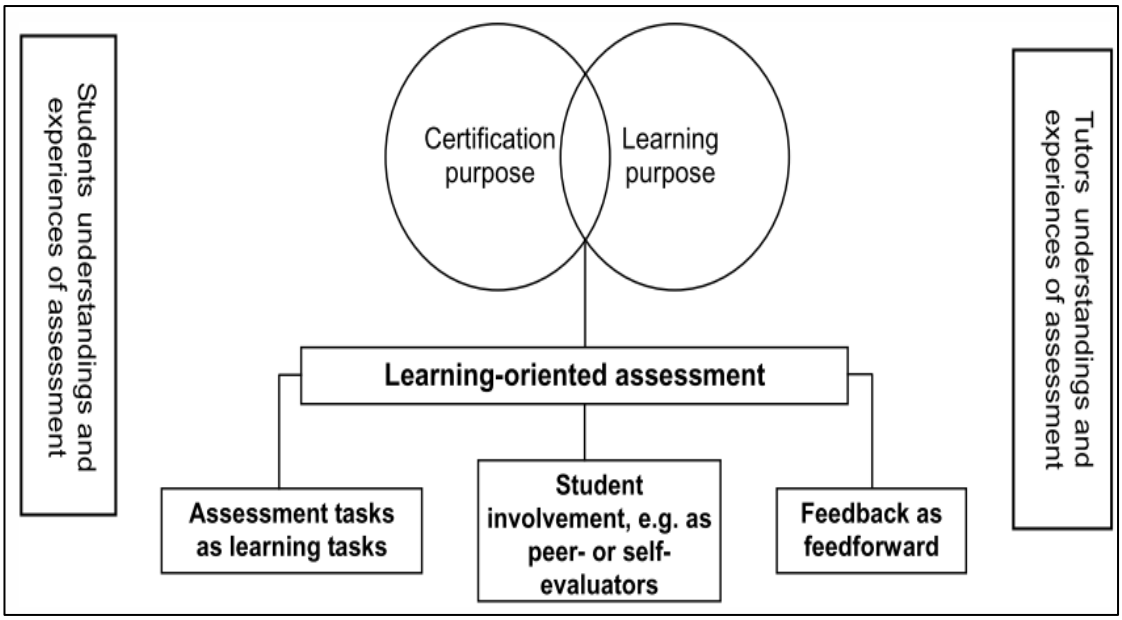


Figure 1: Framework for LOA (Carless, 2007)

Figure 1 illustrates Carless's (2007) framework showing the overlap between certification and learning purposes, and their integration with LOA. LOA is further broken down into three components: Assessment tasks as learning tasks (AfL), student involvement (peer and self-assessment), and feedback as feedforward (formative use of feedback), all while considering the perspectives of both students and tutors.

3.2.1.2. LOA in Technology-Enhanced Learning Environments

Incorporating LOA within technology-enhanced environments presents unique opportunities, but also significant challenges, some of which are further elaborated in the following section. Regarding the opportunities afforded by LOA, digital tools can facilitate immediate and personalised feedback, engage students through interactive assessment formats, and allow for a diverse range of assessment types that cater to different learning approaches and preferences (NFETL, 2015). Initially, LOA served as

the foundational framework guiding this study. This idea of an innovative learning environment is a feature that was added by Zeng et al. (2018) in Figure 2. This amendment to the Carless et al. (2006) framework, in Figure 1, is one that resonated with me in ways that strongly suggest that technological elements could enhance this framework.

Incorporating LOA within technology-enhanced environments presents unique opportunities but also significant challenges, which are further elaborated in the following section. One of the key developments in the LOA framework is the integration of an Innovative Learning Environment (ILE), a concept added by Zeng et al. (2018) to extend the framework proposed by Keppell and Carless (2006). The ILE in Zeng's model promotes a shift towards more dynamic and learner-centred approaches, aligning assessment with strategies like active collaborative learning (ACL), self-directed learning (SDL), research-based learning (RBL), and problem-based learning (PBL) (Zeng et al., 2018). These pedagogical strategies aim to support LOA by creating a rich learning environment where assessment is not isolated but deeply integrated into the learning process.

However, in this study, I interpret and apply the ILE layer differently. Rather than focusing on the various learning strategies such as ACL, SDL, RBL, and PBL, I place emphasis on technology, which is central to what makes the learning environment innovative. For me, the innovative aspect of the learning environment is driven by how technology is integrated into pedagogy and content knowledge. In the section below, the link between these knowledge domains is described.

By integrating technology meaningfully into assessments, the learning environment becomes more interactive, personalised, and responsive to student progress. This differs from Zeng et al.'s focus on collaborative or inquiry-based pedagogies, as my approach foregrounds the technological dimension of the learning environment as a key driver of innovation.

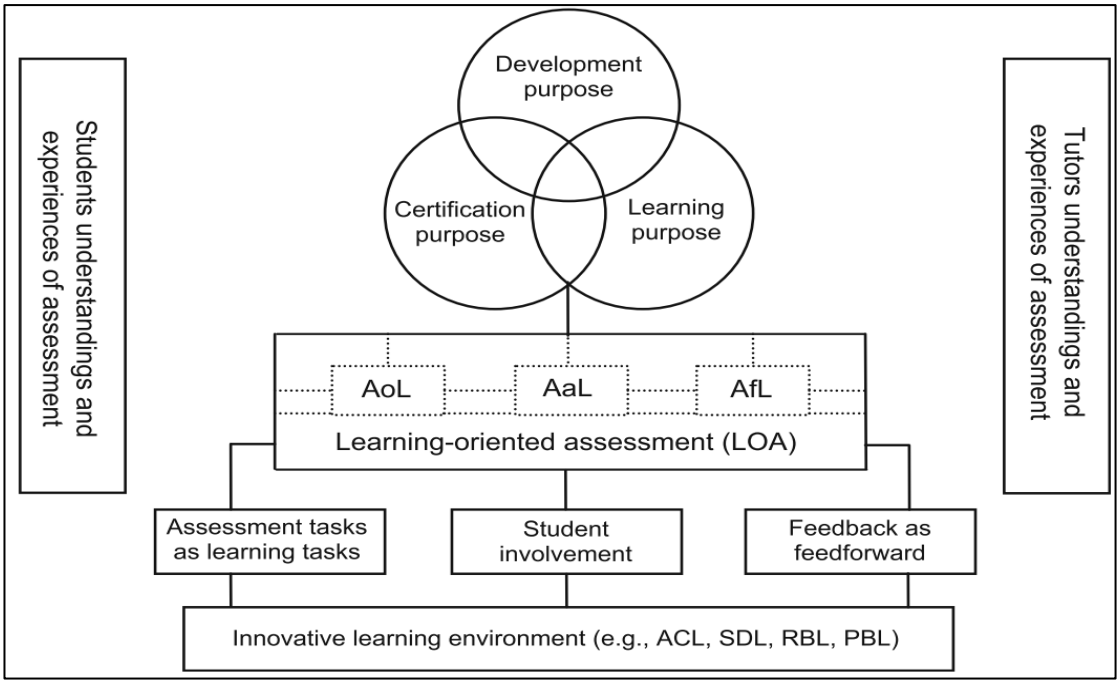


Figure 2. Holistic Framework for LOA (Zeng et al., 2018)

While Zeng et al.'s (2018) ILE framework effectively highlights the importance of pedagogical strategies, my adaptation focuses on how technology can enhance the learning process. This emphasises the integration of digital tools that can align with teaching, learning and assessment goals, ensuring that technology enhances teaching and learning rather than being an add-on. This is particularly crucial in technology-enhanced learning (TEL) environments, where assessments and feedback can be tailored and delivered in more meaningful, timely, and effective ways. By combining LOA, the ILE layer, and digital technology, this study develops a robust model for technology-enhanced formative assessment. The aim is to mitigate the limitations of each framework when applied in isolation and provide a more comprehensive understanding of how formative assessment can operate effectively in technology-driven learning environments.

3.2.1.3. Critical Appraisal of Learning-oriented Assessment

While the principles of learning-oriented assessment (LOA) have been widely embraced, their implementation is not without significant challenges, particularly in the context of modern educational environments. Carless himself has acknowledged several limitations within the LOA framework (Carless, 2007, 2009, 2015b; Carless & Boud, 2018), many of which are directly relevant to this research. This section addresses additional challenges related to its broader implementation and the resistance it often encounters within traditional educational settings.

One major challenge lies in the dominance of summative assessments, which prioritise grading and final outcomes over the formative, learning-focused approaches advocated by LOA. Carless (2007) cautions that "Formative approaches to assessment risk being drowned by the power of summative assessment," (p. 62). This tension is particularly evident in educational environments where the emphasis on summative assessment can overshadow the formative feedback and continuous learning processes that are central to LOA. My research, which centres on formative assessment, is conducted within such a summative-dominated environment, highlighting the difficulty of prioritising learning over grading. Critics such as Price et al. (2010) noted that even well-designed learning-oriented strategies can falter if institutional policies and student expectations remain aligned chiefly with summative outcomes.

Another of these challenges related to the LOA feedback process. Ideally, this process would function as a two-way dialogue between educators and students. However, in settings with large student populations, this personalised feedback process becomes challenging to implement effectively, requiring significant time and effort from instructors. As Hernández (2012, p.500) notes, "Academics reported that large class sizes and the implementation of modularisation are barriers to effective feedback." This issue is exacerbated by the increasing reliance on continuous assessment, which, while beneficial in theory, creates additional demands on educators' time, leading to concerns about the timeliness and effectiveness of feedback (Hernández, 2012, p. 499). Here, the technology element of my research offers a potential solution, facilitating the kind of two-way dialogue that LOA demands even in large classes, by automating certain aspects of feedback and enabling more personalised interactions through digital tools. Crisp (2012) also indicates that e-assessment must be carefully embedded to align with diagnostic, formative, integrative, and summative aims. Without thoughtful curricular integration, technology could complicate rather than simplify the assessment process.

Implementing LOA effectively also requires that educators are well-trained in both its theoretical foundations and practical applications. However, without adequate professional development, the consistency and effectiveness of LOA can be compromised. Hernández (2012) reported instances where feedback, a critical component of LOA, was reduced to a mere grade and a few comments, reflecting poor practices that undermine the potential of LOA. This reinforces the need for continuous

professional development to equip educators with the skills necessary to apply LOA principles effectively, particularly in technology-enhanced environments.

Additionally, while LOA can benefit from technological tools that facilitate ongoing feedback and self-assessment, not all institutions or students have equal access to such tools. This digital divide can lead to disparities in the implementation of LOA, potentially widening the gap between those who have access to high-quality educational technologies and those who do not. Carless (2007) recognised the importance of technology-enhanced assessment within LOA, noting that projects like the Learning-Oriented Assessment Project (p. 60) have explored themes including self-assessment, peer assessment, and portfolio assessment through technology. However, the unequal distribution of these resources remains a challenge that must be addressed. Zawacki-Richter et al. (2019) similarly caution that advanced digital solutions may exacerbate inequities if institutions lack the resources and professional development necessary to support their effective use.

Resistance to change is another significant obstacle. Many educational institutions and educators are deeply rooted in traditional assessment methods, and shifting towards a learning-oriented approach can be seen as a departure from established practices. As Bearman et al. (2014, p. 54) note, “Changing assessment is important for many reasons, but change can often bring resistance,” which highlights how academics sometimes overlook the concerns of colleagues and learners. Overcoming such reluctance often requires deliberate planning, dialogue, and framing new assessment designs in ways that resonate with local priorities (Bearman et al., 2014)

In response to these challenges, my research seeks to adapt and enhance LOA by integrating it with the TPACK framework, which is described in the next section. As explained in Section 3.3, this combination allows for the effective incorporation of technology, not just as a tool for delivering content, but as a means of addressing some of the key limitations of LOA in modern educational contexts. By leveraging technology, the synthesised model used in this study is designed to facilitate the continuous, formative feedback that LOA requires, even in large class settings, and to mitigate barriers of professional development by providing educators with accessible, practical tools. However, as Henderson et al. (2019) cautioned, simply adopting new modes of assessment or feedback will not necessarily improve learning outcomes unless accompanied by robust institutional support and a culture receptive to innovation.

Indeed, Panadero et al. (2019) argued that helping students develop evaluative judgment is a complex process, often hindered by ingrained summative-focused traditions and inadequate staff training. These considerations emphasise the importance of ensuring that LOA implementation is systematically woven into both pedagogical practice and policy structures, rather than treated as an add-on.

While LOA provides a robust framework centred on formative feedback, student-centred learning, and assessment integration, Carless (2007, 2015b) and Carless and Boud (2018) acknowledge it does not explicitly address the foundational requirements for educators to effectively design and implement technology-enhanced assessments. LOA does not inherently guide educators in developing the specific technological, pedagogical, and content knowledge necessary for successful implementation. This omission is significant, as effective formative assessment in digital contexts requires educators not just to understand assessment principles, but also how technology, pedagogy, and subject content intersect. Therefore, another framework needed to be considered. The integration with TPACK proposed in this study addresses precisely this gap, providing the foundational understanding necessary.

3.2.2. Technological Pedagogical Content Knowledge (TPACK)

Originally developed by Koehler and Mishra (2009), the TPACK framework, which emphasises the integration of content, pedagogy, and technology and the knowledge bases of these domains, serves as a critical component of the theoretical foundation for this study. By highlighting the interplay between these knowledge domains, TPACK provides a comprehensive model for enhancing teaching effectiveness in modern educational contexts. This framework is particularly relevant for designing assessments and providing feedback in technology-enhanced environments, where the integration of digital tools is essential.

The methodological implications of applying TPACK in this research are significant. TPACK performs a critical function by informing the selection of digital tools that are pedagogically sound and content appropriate. This ensures that technology is used not merely as an add-on but as an integral part of the learning process. Moreover, TPACK shapes the approach to data collection and analysis by guiding the integration of technological, pedagogical, and content knowledge in research design. This ensures that the research methods align with the study's objectives and are capable of effectively

addressing the research questions. In the following sections, I also critically evaluate TPACK, identifying its strengths and limitations within the context of this study.

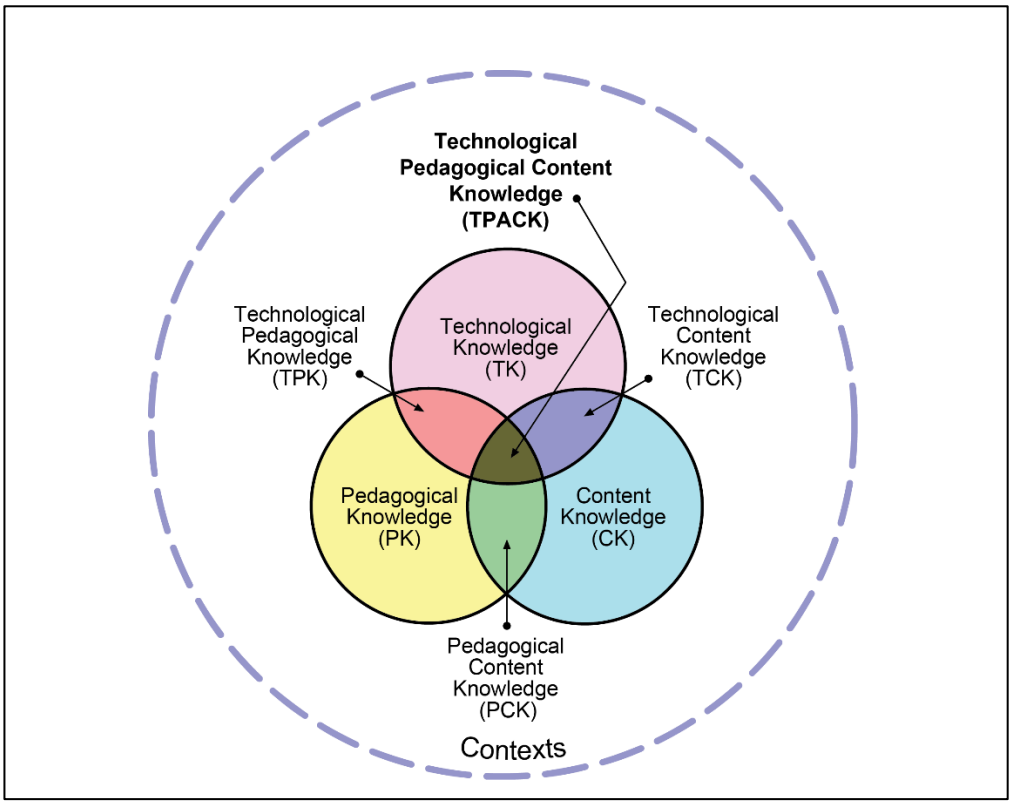


Figure 3. TPACK Framework and its Knowledge Components (Koehler & Mishra, 2009)

As shown in Figure 3, TPACK identifies the types of knowledge educators need to teach effectively using technology, with emphasis on the interplay between three primary forms of knowledge:

- Content Knowledge (CK): expertise in the subject matter being taught.
- Pedagogical Knowledge (PK): understanding how to teach, including methods, practices, and strategies.
- Technological Knowledge (TK): standard technologies and advanced digital tools.

The work of Koehler and Mishra (2009, p. 62) highlights that "equally important to the model are the interactions between and among these bodies of knowledge, represented as PCK, TCK (technological content knowledge), TPK (technological pedagogical knowledge), and TPACK." The interaction of these core domains results in a holistic integration of CK, PK, and TK, forming the central knowledge domain of TPACK.

In modern educational settings, especially those enhanced by digital technologies, TPACK provides a useful framework, when it comes to designing and delivering

content (Koehler et al., 2013; Voogt et al., 2013). This aims to make technology integration meaningful and beneficial for both teaching and learning experiences. The integration of Assessment for Learning (AfL) and Assessment of Learning (AoL) is particularly crucial in digital learning environments because these environments demand a more sophisticated approach to assessment that accounts for both ongoing learning processes and final outcomes. The TPACK framework supports this integration by ensuring that the technology used in these assessments is pedagogically sound and aligned with the content being taught. By guiding the selection and implementation of digital tools, TPACK helps educators to design assessments that are not only effective in measuring learning outcomes but also in fostering student engagement and providing timely, relevant feedback. This integration is essential for meeting the research objectives, as it offers a comprehensive approach to designing and implementing educational assessments that enhance student learning experiences and outcomes in technology-enhanced environments. The integration of TPACK with LOA is explored in further detail in Section 3.3.

3.2.2.1. Critical Appraisal of TPACK

While TPACK offers a valuable conceptual framework for integrating technology into teaching, it is not without its limitations, as highlighted by scholars such as Graham (2011), Brantley-Dias and Ertmer (2013) and Voogt et al., (2013). One of the primary critiques is that TPACK tends to focus more on practical applications rather than being grounded in solid theoretical underpinnings. Graham (2011) points out that this emphasis on practicality may come at the expense of a solid theoretical foundation, suggesting the need for a more comprehensive theoretical base to support TPACK's application in diverse educational settings. The abstract nature of TPACK also introduces complexity, leading to diverse interpretations that can make it challenging to operationalise. Brantley-Dias and Ertmer (2013) argue that if TPACK is conceptualised as the knowledge base necessary for effective technology integration, there needs to be a clearer understanding of what this knowledge entails, particularly for specific subject domains. From their conclusion, it can be inferred that this ambiguity presents a significant challenge for educators trying to apply TPACK principles in practice, as it may not provide clear guidance on how to tailor technology integration to different content areas.

Another major limitation of TPACK is its lack of specific implementation guidelines. Brantley-Dias and Ertmer (2013) observe that the current TPACK framework does not offer clear directions on what types of pedagogy or curricula are most suitable for technology integration. The authors go on to say that his lack of specificity can leave educators without a clear path, making it difficult to effectively apply TPACK in diverse educational contexts. Furthermore, Voogt et al. (2013) caution that TPACK, while intuitive and easy to communicate, is theoretically complex and can sometimes place undue emphasis on technology at the expense of pedagogy and content. This critique reinforces the importance of ensuring that technology does not overshadow other essential elements of teaching and learning. The effective implementation of TPACK also requires substantial training and professional development. Brantley-Dias and Ertmer (2013) emphasise the need for ongoing clarification and discussion to guide future educational efforts effectively. The authors suggest that without sufficient professional development, educators may struggle to apply TPACK principles in a meaningful way, leading to inconsistencies in its implementation. Graham (2011) further highlights the need for more defined guidelines and resources to support educators in applying TPACK, noting that the research community has not yet done the necessary theoretical work to clarify the distinctions between the model's elements.

While it is clear that TPACK provides a valuable framework for understanding the integration of technology, pedagogy, and content, on the one hand, these critiques rightly indicate that its limitations must be carefully considered. In the context of my research, these critiques have inspired the development of an integrated framework that combines TPACK with Learning-Oriented Assessment (LOA). This integration seeks to address the gaps in TPACK by grounding the framework in a solid theoretical foundation provided by LOA, which emphasises the role of formative assessment and feedback in the learning process. Furthermore, by integrating TPACK with LOA, my framework aims to balance the emphasis on technology with a strong focus on pedagogy and content. This approach ensures that technology is used, not merely as an end in itself, but as a tool to enhance learning and assessment practices. The combined framework also addresses the need for clear implementation guidelines by providing a structured approach to technology integration that is closely aligned with pedagogical goals and content knowledge. Finally, recognising the importance of professional development, my research includes strategies for supporting educators in applying this

integrated framework effectively, thereby mitigating the challenges associated with TPACK's implementation.

Although TPACK effectively addresses the integration of technology, pedagogy, and content knowledge, critics like Graham (2011) and Brantley-Dias and Ertmer (2013) point out that it falls short in providing a sufficiently clear and practical framework for assessment-focused educational contexts. TPACK lacks explicit attention to principles of formative feedback, student-centred assessment practices, and the specific pedagogical nuances required for effective assessment integration. As explained in Section 3.3, the synthesis with LOA proposed in this study mitigates these limitations by embedding TPACK within a clearly articulated framework that prioritises formative assessment, feedback practices, and student engagement, thus grounding TPACK's technological focus in established educational assessment theory.

3.3. Integrating the Theories and Models: Creating a Synthesised Framework

As the landscape of education is undergoing transformation, the need for a holistic, adaptable, and technology-enhanced approach to learning and assessment is increasingly important (Slade et al., 2022). To address this need, I developed an innovative model synthesising Carless's LOA principles with the TPACK framework. This integrated model was designed to explicitly address the complexities of effectively integrating technology with pedagogical innovation and dynamic assessment strategies, leveraging the complementary strengths of each framework.

The rationale for integrating LOA and TPACK into a synthesised framework arises directly from recognising the distinct limitations of each model when applied independently. LOA, while strong in formative assessment and feedback practices, does not sufficiently guide educators in the foundational areas of content knowledge, pedagogy, and especially technological integration. Conversely, TPACK provides robust guidance on integrating these foundational domains: content, pedagogy, and technology, but lacks explicit theoretical clarity around formative feedback processes, student-centred learning practices, and assessment-specific pedagogical insights. By synthesising LOA with TPACK, this study explicitly addresses these gaps. It situates technology-enhanced formative assessments within a comprehensive theoretical approach that starts with the fundamental understanding of how to teach effectively with

technology (TPACK) and then integrates this knowledge into a clearly articulated, feedback-rich, student-centred assessment framework (LOA). Thus, this integrated framework offers a new theoretical contribution by providing educators and researchers with a holistic model explicitly designed to optimise formative assessment within technology-enhanced environments.

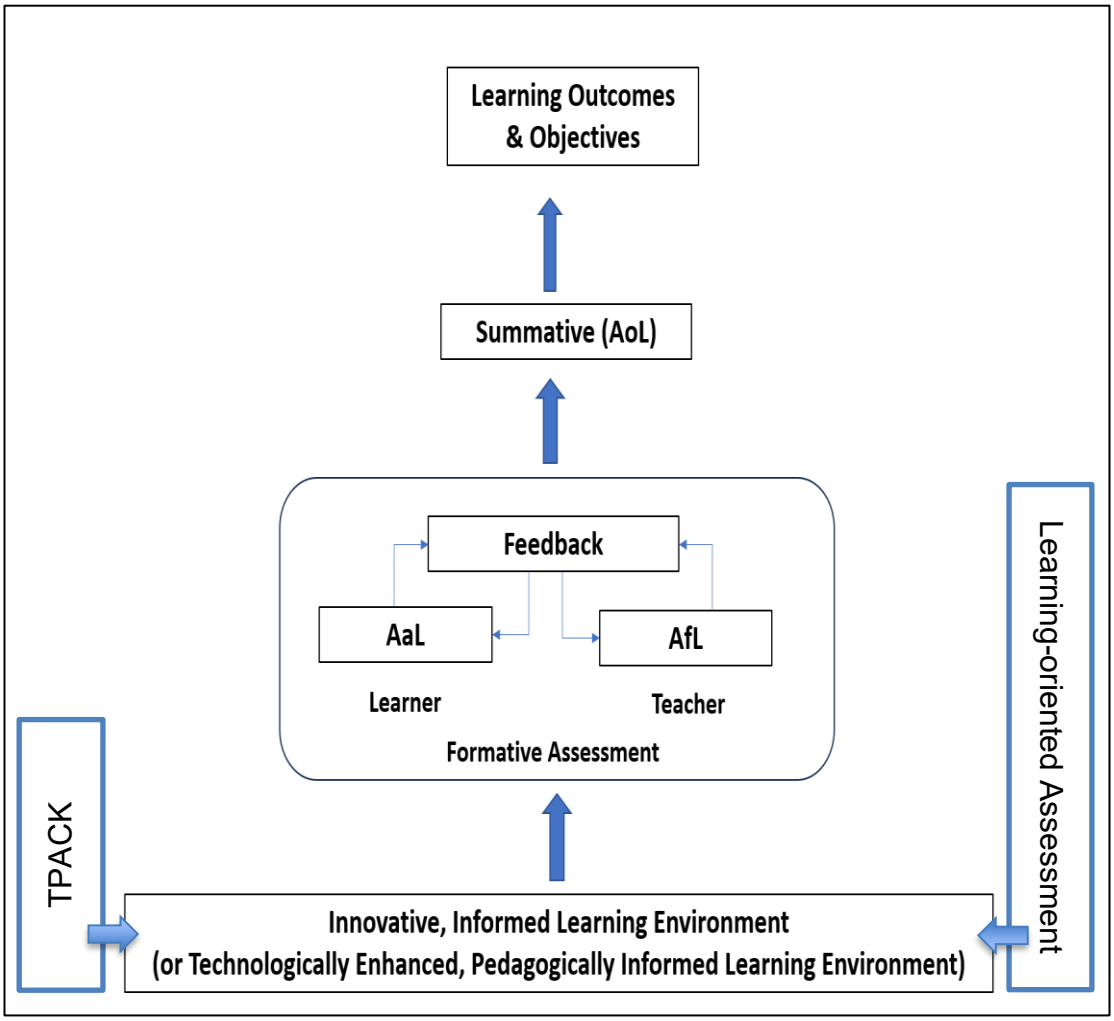


Figure 4. Theoretical Framework for this Study (customised version of LOA with TPACK)

The model developed for this study is structured using four interrelated layers, each of which reflects a stage in the teaching and learning process for the module at the centre of this study. These layers build on each other, starting with a foundational layer at the bottom, grounded in the TPACK framework, which integrates content, pedagogy, and technology to create an informed and innovative learning environment. The next layer up focuses on the operational phase of teaching and learning, where formative assessments and interactive learning activities are implemented. Incorporating principles from both Assessment for Learning (AfL) and Assessment as Learning (AaL), this stage emphasises the role of continuous feedback and student engagement

in deepening the learning experience. Moving upwards, the third layer addresses Assessment of Learning (AoL) through summative assessments, such as end-of-term exams, which measure students' overall mastery of course content. This layer ensures that formal academic achievements are balanced with a holistic understanding of the learning journey. At the top of the model, the focus is on defining and achieving the course's overarching learning outcomes and objectives. This layer aligns the entire educational process with broader goals, such as content mastery and the development of self-regulated, lifelong learners. Throughout the model, a dynamic action research approach is employed, allowing for cycles of reflection and adaptation. This ensures that the model remains responsive to shifting educational needs, ultimately supporting a comprehensive, student-centred, and TEL environment. Details of the model are as follows:

Bottom Layer: Innovative, Informed Learning Environment

The bottom layer of my theoretical framework highlights how the integration of Learning-Oriented Assessment (LOA) principles with the TPACK framework is crucial for establishing an innovative, informed learning environment. The LOA principles central to this layer include the emphasis on formative assessment, feedback as a tool for learning, and the active involvement of students in the assessment process. These principles, when integrated with TPACK, enhance the alignment between technology, pedagogy, and content to create a cohesive and effective educational strategy. This integration further expands the Innovative Learning Environment concept that Zeng et al. (2018) added to the Carless model. In this foundational layer, the focus is on leveraging the strengths of each TPACK domain: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK), to design a comprehensive educational approach. These domains are interdependent, with each one supporting the others to ensure that content, pedagogical goals, and technological capabilities are effectively aligned during curriculum planning.

Rather than setting specific objectives, this foundational layer explores the relationships and interactions among the TPACK domains. This includes selecting appropriate technological tools that complement pedagogical goals, integrating current educational research to maintain relevance, and fostering an interactive, inclusive learning environment. Continuous feedback from students and ongoing professional development for educators play pivotal roles in maintaining the effectiveness and

engagement of this environment. However, it is important to acknowledge the complexity of this foundational layer. Effective operationalisation of the strategies within this layer requires significant prerequisites, such as educators' proficiency in both the TPACK domains and LOA principles, as well as the availability of appropriate technological resources and institutional support. These elements are essential for creating a well-designed, technology-enhanced environment that not only supports content delivery but also fosters active learning and student engagement.

Middle Layer: Assessment and Learning Activities

The middle layer of the theoretical framework centres on integrating AfL and AaL. AfL provides ongoing, formative feedback that guides both educators and students in tracking learning progress. AaL empowers students by actively involving them in self-assessment, peer assessment, and reflective practices, deepening their understanding of their learning journey. This active engagement fosters metacognitive skills and reinforces learner autonomy, positioning students as agents in their own learning process. Digital tools such as quizzes and learning dashboards can further support AaL by enabling self-monitoring and goal setting. Feedback is a crucial component within this layer. At this juncture, students receive timely, constructive insights that help them to identify areas for improvement and to apply this knowledge to future activities. Educators deliver feedback that is both informative and motivating, fostering a collaborative learning environment. This layer emphasises continuous and varied formative assessments, including quizzes, discussions, projects, and reflective journals, to cater to different learning approaches. All assessment activities are closely aligned with the learning objectives set in the top layer of the model, ensuring relevance and effective measurement of outcomes. Consistent with the TPACK foundation, leveraging technology plays a key role, with tools like online quizzes and Moodle used to enhance assessment practices, provide continuous feedback, and track student progress. Both educators and students are actively involved, with educators designing and implementing assessments and guiding students in AaL activities. Students are encouraged to view assessments as opportunities for growth. The outcome is an engaging, dynamic learning process where assessments drive deeper understanding, critical thinking, and self-assessment skills. Educators gain valuable insights into the effectiveness of their teaching strategies, allowing for informed decisions to enhance

the learning experience. This layer affirms that assessments are not merely tools for measurement but integral to the learning journey.

Upper Middle Layer: Assessment of Learning (AoL)

The upper middle layer of the theoretical framework focuses on Assessment of Learning (AoL) through summative assessments, such as end-of-term exams. This layer recognises the significance of formal academic achievements while maintaining a holistic view of the learning journey. In this research, the end-of-term exam is a key element, measuring students' overall mastery of course content and serving as a fixed component due to professional body requirements. Summative assessments are closely aligned with the course's learning objectives, ensuring that exams not only test factual knowledge but also assess students' ability to apply, critically analyse, and synthesise information. This alignment ensures that summative assessments accurately reflect the intended learning outcomes. Educators play a vital role in designing comprehensive and fair assessments that are integrally connected to the learning experience, synthesising the concepts and skills developed throughout the course. Post-exam feedback is essential, offering insights into performance that help students identify strengths and areas for improvement, guiding their future learning strategies. A key aspect of this layer is student preparation for summative assessments, which includes content revision, exam-taking strategies, and time and stress management. Students are encouraged to self-evaluate and reflect on their learning, with a view to deepening their understanding of course material and boosting their readiness for exams.

Top Layer: Learning Outcomes and Objectives

Finally, the top layer of the theoretical framework is dedicated to defining and articulating the course's overarching learning outcomes and objectives. This layer articulates that the entire educational process should be aligned with the broader goals of content mastery and the development of self-regulated, lifelong learners. Referencing Carless's (2007) LOA model, the learning objectives encompass the mastery of content, while simultaneously prompting the student to develop as autonomous, self-regulating learners. Beyond knowledge acquisition, the learning goals set out in this layer aim to foster critical thinking, problem-solving skills, and the ability to apply knowledge in real-world contexts. This broader educational perspective helps to ensure that students are not only absorbing information but are also developing essential life and career skills. These objectives are aligned with broader educational aims, such as fostering

lifelong learning skills, enhancing students' ability to work collaboratively, and preparing them for future challenges in their academic and professional lives.

As with other layers, educators again play a crucial role in guiding students toward achieving these objectives. This involves designing course content, teaching methods, and assessment strategies that collectively work towards these goals. Throughout the course, educators continuously reinforce these objectives, integrating them into every aspect of the learning process, from classroom discussions to assessment tasks. This continuous reinforcement ensures that the educational journey is coherent and purposeful.

Educator input aside, students are encouraged to take an active role in setting their personal learning goals, aligned with the course objectives. Developing self-regulation skills is a key focus that enables students to monitor, evaluate, and direct their own learning. This aspect not only contributes to academic success, but also fosters personal growth and development. The outcome presented in the top layer is the realisation of the course's educational aspirations. Students who complete the course successfully are expected to demonstrate mastery of the content and exhibit advanced skills in critical thinking, self-regulation, and the application of knowledge. These learning outcomes lay a strong foundation for future learning endeavours, equipping students with the skills and knowledge necessary to navigate the complexities of further education and professional careers. This top layer acts as the guiding principle of the entire educational process, setting the direction and purpose for all activities and assessments that occur in the layers below.

3.3.1. Application of the Synthesised Theoretical Framework

As outlined above, this research uses the theoretical framework that I developed to guide the design, implementation, and analysis of TEFAs. Combining Carless's LOA principles with Koehler and Mishra's (2009) TPACK framework, this model helped frame the research and guide all aspects of the research process, which in turn facilitated a deeper exploration of the impact these assessments made on student engagement and learning. By grounding this study in the principles of LOA and TPACK, I have ensured that the practical interventions are well-informed and aligned with established educational theories.

The framework supported a dynamic action research approach throughout the study, facilitating cycles of reflection and adaptation. Regular feedback from students and

educators informed improvements to assessment strategies and learning activities, ensuring that the framework and intervention remained responsive to educational needs. The following chapter situates this framework within the methodological design of the study, detailing the processes through which data were collected, analysed, and interpreted in alignment with the theoretical foundations established here.

In summary, neither LOA nor TPACK alone sufficiently addresses the full complexity of integrating technology, pedagogy, content knowledge, and formative assessment in higher education contexts. LOA excels at clarifying formative assessment practices and feedback but lacks explicit guidance on foundational teaching competencies and technological integration. Conversely, TPACK provides foundational clarity on technology use in educational contexts but does not explicitly address formative assessment strategies, feedback, or student-centred learning practices. By integrating these frameworks, this study has developed a comprehensive, multi-layered theoretical model that addresses these individual limitations and offers educators a coherent approach to designing and implementing technology-enhanced formative assessments. This integration constitutes a significant theoretical contribution, offering new practical and conceptual insights that bridge the gap between assessment theory, pedagogy, and educational technology.

Chapter 4: Research Methodology

This chapter outlines the methodological framework of this study, identifying Participatory Action Research (PAR) as the chosen methodology. This decision is rooted in the study's ontological and epistemological stance, which recognises knowledge as socially constructed and actively co-created between the researcher and participants. The participatory and iterative nature of PAR made it the most appropriate approach for investigating and improving educational practices within the specific context of my own teaching environment.

The chapter begins by providing a rationale for selecting PAR over other methodologies, explaining how this approach aligns with both the research objectives and my role as a practitioner-researcher. It highlights the active involvement of students as participants and collaborators in aspects of the research process, like the design of the TEFAs, reinforcing the participatory aspect of the methodology. Additionally, the chapter explains the iterative nature of action research, with each cycle of research informed by the previous one to drive continuous improvement in teaching and learning practices.

A detailed overview of the three action research cycles, conducted over a two-year period gives the reader a clear understanding of the research timeline. The chapter then discusses the variety of data collection methods used, including surveys, focus groups, observational notes, and online learner analytics, explaining how these methods contributed to triangulation and the depth of the findings. Ethical considerations, particularly related to power dynamics, are also explored, with attention given to the steps taken to address these concerns in the context of researching my own students.

Research Objectives and Methodological Approach

The primary objective of this research was to explore whether technology-enhanced formative assessment (TEFA) can improve student engagement and learning outcomes. To achieve this objective, a TEFA intervention was designed and implemented over three action research cycles, allowing for continuous reflection and adaptation of my own pedagogical practices. I hypothesised that well-designed formative assessments, supported by technology, would not only enhance student learning but also improve my own efficiency and effectiveness as an educator.

Since a secondary objective of this research was to help me, as the practitioner-researcher, improve my educational practices, it was crucial that I be actively involved in the process. The students were seen not as objects of research but as important partners in the process, echoing Sullivan's (2006, p. 139) view of students as "equal participants." This collaborative, participatory approach is central to PAR, and my choice of this methodology was driven by a desire to work alongside my students to improve the educational experience. McTaggart's (1997, p. 39) description of participatory action research encapsulates my approach to this study:

> Action research is not research done on other people. It is research by particular people on their own work, to help them improve what they do, including how they work with and for others. It does not treat people as objects for research, but encourages people to work together as knowing subjects and agents of change and improvement.

Although the field has evolved since then ((Brydon-Miller & Maguire, 2009; Harrison, 2013; Brydon-Miller et al, 2017), McTaggart's call for a collaborative thinking remains widely accepted and aligns strongly with my own commitment to working in partnership with my students.

4.1. Overall Approach

An investigation of my values and commitments was necessary in order to clarify my ontological, epistemological and methodological positions in relation to this research. Hitchcock and Hughes (1995) suggest that ontological assumptions give rise to epistemological assumptions which in turn give rise to methodological considerations, and these then give rise to issues of instrumentation and data collection.

The research question was my starting point for trying to understand my ontological and epistemological approach to this research. From there, I arrived at the conclusion that I should use a social constructivist and interpretivist research paradigm, with an action research approach using a diverse range of data gathering tools. That process is detailed in the next section.

Positionality and Personal Perspective

From an early age, I was taught that absolute truth can be elusive. My father liked to say, *"There are three sides to every story: his, hers, and the truth,"* to remind me that each person sees an incident, say a fight in the school yard, a car accident, through their own lens. Another thing he would regularly say when I was trying to make a decision was: *"Ask everyone what they think and then make up your own mind."* Both of these

statements have shaped my outlook in the search for truth and knowledge. Consequently. I grew up realising that no universal perspective exists and that "the truth" is often shaped by who is telling the story. Almost 140 ago, Friedrich Nietzsche shared similar views. When discussing perspectivism he noted that *"*This–it turns out is my way where is yours?–That is how I answered those who asked me 'the way.' The way after all–it does not exist!" (Nietzsche 1883-1885, as cited in Nietzsche 2006, p. 156). He suggested that there is no single way of doing things, suggesting that right and wrong, correct and incorrect, can be very subjective.

When Donald Rumsfeld famously distinguished between "known knowns," "known unknowns," and "unknown unknowns," (Secretary of Defence Donald H. Rumsfeld, 2002), I initially saw it as political spin. However, it also reminded me of Johari's window (Luft & Ingham, 1961) and how, in education or business, there can be areas we are aware we do not understand, and other areas we do not even realise exist. This is a particularly relevant outlook that I teach to my students in my technology and business modules.

Reflecting on concepts like ontology and epistemology felt a bit like navigating those "unknown unknowns" at first. As I questioned this further, I moved into the realm of "known knowns" and began to articulate where I stood. Ultimately, I discovered that I do not believe in one single reality, especially in education. I see the social world as understandable only through the perspectives of those directly involved. That means I lean toward a social constructivist view: knowledge is actively constructed rather than passively received. Furthermore, I take an interpretivist stance on how we come to know things, focusing on meaning, context, and individual experiences rather than just raw data or empiricism. In line with these views, I adopted a mixed inductive–deductive approach for this research, influenced by Francis Bacon's idea that important patterns often emerge when we gather enough data with an open mind (Mouly, 1978; Cohen, Manion and Morrison, 2018a). Put simply, I see myself as an "alert observer," prepared to spot relationships in the data as they unfold, rather than forcing my findings to fit preconceived theories. This openness works well with action research, where continuous cycles of planning, acting, and reflecting let the data shape how the study evolves.

This thesis reflects the beliefs about multiple viewpoints, social interaction, and constructive exploration that underpin my entire research design. By grounding this

project in a personal philosophy that acknowledges each participant's unique reality, I hope to stay true to the spirit of collaboration and continuous learning that have guided my own development.

From Educator to PhD Researcher

As an educator I now realise that I deal with uncertainty in the classroom on a daily basis. My teaching style has changed over the years as I do less "chalk and talk" and more discussion-based and problem-based learning. How I deal with uncertainty now as a mid-career professional is different to from how I would have dealt with it in my first year of lecturing. This poses the question: Does this mean my ontological stance has changed over time?

My social epistemology means I deal with the uncertainty in a positive way. The realisation that I do not know everything and being comfortable with that, makes this uncertainty less stressful. This "comfort" has only come in the past few years. Grad (2009) poses interesting questions such as: If we are unaware of our epistemology or how it influences our practice, then what benefits would such awareness bring? Also, to what extent does experience or maturation lead to a change or shift in epistemology? These questions prompted me to unpack my day-to-day teaching and learning activities and forced me into a period of metacognition.

My constructivist approach to knowledge means I welcome the fact that knowledge is created in the classroom with each interaction I have with the students, or between themselves. In times gone by, I would have lacked the confidence to embrace this and also, I had a more positivistic outlook that convinced me that what I preached in the classroom was 100% correct, because it came from the course textbook.

At the time of writing, I am constantly questioned by students and challenged to revisit my knowledge on certain topics. The nature of my subject area, business and technology, means that it is constantly moving forward, and often the students are more up to date than I am on new developments in particular areas. This not only means that the verified facts of yesterday are out of date today, but also that entire business practices and frameworks of understanding are shifting. For example, the rise of generative AI is fundamentally altering how businesses approach innovation, customer interaction, and even the concept of creativity itself.

In my current practice, as an educator, I believe that knowledge is constructed. While a positivistic approach to research, which often aligns with a more traditional scientific

method, might offer the advantage of clear conclusions and generalisability, it does not fully capture the complexity and participatory nature of the educational environment I am investigating. Given my active role in this research, I carefully considered the scientific approach but ultimately decided that action research was more appropriate as this approach not only allows for a deeper engagement with the research participants but also supports the use of a variety of data-gathering tools, including both qualitative and quantitative methods. The iterative cycles of action research are particularly well-suited to the developing and reflective nature of this study, enabling me to draw meaningful insights that are directly applicable to improving educational practice. In Section 4.2.1 below, I further justify my choice of action research as the most suitable methodology for this project. Before that, it is important to explain some of the characteristics of this approach.

4.1.1. Assumptions in Action Research

In this section, I expand on the concepts of ontology, epistemology and methodology. As stated previously, my understanding of these areas of philosophy started with an investigation into my research question. From this, I worked backwards to clarify my philosophical position in relation to my action research.

Ontology

According to McNiff & Whitehead (2011), the ontological commitments that underpin action research are value laden and morally committed with researchers perceiving themselves as being in relation with one another in their social contexts. In this section, I define each of these commitments and indicate how they connect to my positionality as a researcher.

Value Laden

While the positivist approach explains the way things work by establishing a cause and effect between two variables, McNiff & Whitehead (2011, p. 28) argue that action research is carried out by people who are trying to live according to the values that inspire their lives. In action research, values act as guiding principles in the research. Action research often begins by articulating values. For me, values like fairness, honesty, efficiency, and practicality are important. For this research, these same values were evident as I researched technology that might be more efficient than my current practice, so I needed to be fair and honest in terms of correcting and objectively giving timely feedback. I would also hold an overriding value of being student-centred.

Morally Committed

Doing action enquiry involves what inspires you to do things as you do, and what you hope to achieve (McNiff & Whitehead, 2011). As part of this research, I aimed to improve the formative assessment and effective feedback aspect of my practice. I believe this element of my teaching is "good," but could be a lot better. I understand that my definition of "good" is very subjective. For all I know, an independent observer might rate it as "excellent" or "poor". My rating was based on my experience to date as an educator, feedback from students, module evaluations, comparisons with other lecturers, CPD courses and my previous studies in the MA in Learning and Teaching. While no major generalisations would be drawn from my research, if I could demonstrate improvements for me as an educator and my classes as learners, there should be lessons to be learned for colleagues and other educators in similar fields in the higher education sector.

Social Contexts

An increasingly important perspective in action research is the development of relational and empathetic values (Dadds, 2008). As a student-centred educator, I believe I have both of these values. Cohen et al. (2011) explain that the core idea of transformational capacity enables people to incorporate the insights of others and transform them as living theories of practice are created. Action researchers always see themselves in relation with others, in terms of their practices and also their ideas, and also with the rest of their environment. They undertake enquiries with others, recognising that people are always in company. The idea of never being alone is key. Although the focus of the enquiry is you, as you ask, 'How do I improve what I am doing?' your question automatically assumes that any answer will involve other people's perception of your influence in their learning. Again, this is the essence of my research, and the action research approach fits perfectly.

Epistemology

McNiff and Whitehead (2011, p. 30) state that "epistemology is to do with how we understand knowledge, and how we come to acquire and create knowledge." They go on to explain that the epistemological assumptions underpinning action research are that the object of the enquiry is in the "I," knowledge is uncertain, and knowledge creation is a collaborative process.

Given my research questions, trying to figure out a process to answer them forced me to reflect on my own epistemological stance. Because I wanted to uncover knowledge of social behaviour, specifically learning in my own classroom, it was not realistic to hold the view that knowledge is hard, objective and tangible. Instead of being an impartial observer, I recognised that I would be an active participant in the research, involved with my test subjects. To this end I saw knowledge as personal, subjective and unique. I believed that the knowledge for both the student and I would be constructed as I engaged in the iterative process of action research. For my specific topic and situation, this chapter shows how action research was the most suitable methodological approach. Furthermore, I argue that action research aligns well with the principles of formative assessment, as both approaches emphasise continuous feedback, reflection, and improvement.

Later in this chapter, I explain how self-reflection was an important element of this research, where the focus included both examining my practices and understanding students' experiences. In the process of studying oneself, the questions often focus on personal actions and improvements, such as, "What am I doing? How do I improve it?" rather than solely asking, "What are they doing? How do they improve it?" However, because this research also aimed to enhance student engagement and learning, examining students' responses to the intervention was essential. This dual focus allowed me to reflect on my role as an educator while also considering students' experiences, holding myself accountable not only for what I do but also for how it impacts them (McNiff & Whitehead, 2011).

Berlin (1998) stated that traditional positivist researchers tend to believe that knowledge is certain, and assume that there is an answer to everything and that knowledge can be discovered using specific methodologies such as the "scientific method," which aims to predict and control outcomes. McNiff and Whitehead (2011, p. 32) further explain that this perspective may be valuable when it is a case of genetic engineering or weather forecasting, but it does not necessarily work in relation to real human practices, because humans are unique and unpredictable, and make their own choices. In my classroom, such predictability would be unrealistic. Action researchers, in contrast, tend to assume the following:

1. There is no one answer. Knowledge is uncertain and ambiguous. A question may generate multiple answers.

2. Knowledge is created, not only discovered. This is usually a process of trial and error. Provisional answers, and the process itself, are always open to critique.
3. Any answer is tentative, and open to modification. Answers are often incommensurable and cannot be resolved. People just have to live with the dissonance and do the best they can.

(Berlin, 1998, as cited in McNiff & Whitehead, 2011)

This means that action researchers do not look for a fixed outcome that can be applied everywhere. Instead, they produce their personal theories to show what they are learning and invite others to learn with them. Rather than focusing on generalisability or replicability, which are often important in some areas of social science, action researchers judge their work in terms of how well it aligns with their educational and social values, using these values as their living standards of judgement (McNiff & Whitehead, 2011).

Although the "I" is central, the "I" should never be understood as in isolation. We all live and work in social situations. Whatever we do in our professional practices potentially influences somebody somewhere. Action research means working with others at all stages of the process. At the data gathering stage, researchers investigate their practice in relation to others, and at the validation stage, findings are negotiated with others.

Given my ontological stance that knowledge is socially constructed and context-dependent, and my epistemological view that such knowledge emerges through interpretive, collaborative processes, I locate this study within a social constructivist–interpretivist paradigm. This paradigm underpins the participatory nature of action research, enabling ongoing dialogue and reflexivity between me (the practitioner-researcher) and my students. By acknowledging this worldview, my inquiry seeks to understand and improve practice in a manner consistent with the interpretivist emphasis on meaning, context, and the co-construction of knowledge.

4.2. Participatory Action Research

4.2.1. Why Participatory Action Research?

There are many reasons why participatory action research was the approach of choice for this research, the main one being that it aligns with my epistemological stance and the nature of the research questions. As an interpretivist, I view knowledge as something that is co-constructed through interactions, rather than something that is discovered or

fixed. Action research, with its participatory and iterative nature, allowed me to actively engage with participants and collaboratively generate knowledge through cycles of reflection and action. This approach reflects my belief that knowledge is context-dependent, socially constructed, and continuously changing based on the experiences and perspectives of those involved. This section will also justify the reasons for not choosing alternative research approaches.

When evaluating various action research approaches, I was initially concerned by some of the characteristics and language of action research. I was clear in how my research differed from these elements and it crystallised what my research did not set out to achieve, which was an important starting point. I was clear that this research was not about "the need for justice and democracy…or the deep need to experience truth and beauty in our personal and professional lives," (McNiff, 2002, p. 5). It was not about advocacy of democracy, emancipation or collaboration in search of morally correct ways of understanding the world (Creswell et al., 2007). This research was not communitarian and seeking to bring about social change (Maguire, 1987) and improvements to the quality of people's lives in oppressed and exploited communities (Stringer, 1999). This type of language comes up a lot in relation to action research, so it was a relief to find out that there are different types of action research and see how my research approach spanned more than one of them.

While my initial concerns stemmed from action research's association with social justice emancipatory aims, further exploration showed that action research is flexible and can accommodate various approaches that do not necessarily involve social change. This realisation confirmed that action research was the most suitable methodology for my study.

Action research was ultimately selected because it allows for a reflective, iterative process that aligns with my goal of improving educational practices and enhancing student engagement. This methodology supports a collaborative approach, where learners actively participate in the process, following the principles of double-loop learning (Argyris, 1977) and reflective practice. The unpredictable and complex nature of educational environments further supports the use of action research, as it embraces the dynamic and non-linear aspects of these settings.

This section also highlights the transformational potential of action research for both educators and learners, as well as its role in supporting continuous professional

development. By integrating TEFA into this framework, the research aims to bring about meaningful and sustainable improvements in educational practices. The combination of formative assessment and action research creates an iterative process of feedback and refinement, ultimately improving student engagement and learning outcomes.

Technical and Practical Action Research

Carr and Kemmis (1986, p. 469) distinguished three kinds of action research: technical action research, practical action research and critical action research. Based on my reading of the literature, I would position my action research approach as a mixture between technical action research and practitioner action research, as explained below.

In technical action research, the participant-researcher aims to improve the outcomes of their practice. The practice is regarded as a means to an end, capable of being improved to be more effective or efficient in producing known ends. Grundy (1994) argues that "technical" action research is designed to render an existing situation more efficient and effective, to improve outcomes of practice. While my 'end' was unknown, my task as the participant-researcher was to improve the means, in this case, my own practice. This involved changing the way others were involved in the practice, i.e., the way students learn, while an equal focus remained on me, the practitioner.

A characteristic of practitioner research that is evident here is that the learners involved were not treated in the third person, as the objects of my action. Instead, they were treated as persons who are as much subjects in the process as the practitioner. This is where my approach moves into practitioner action research. It was a collaborative yet consultative process where learners provided valuable input on what was to be done, what could be changed, and how to interpret the observations, with final decisions guided by my role as the researcher. It was not an "intransitive, one-way relationship between the participant-researcher and the others involved in or affected by the research," (Kemmis, 2009, p. 469). By having the learners involved, it also gave them a voice, and this would help them commit to the interventions. By acting more prudently, and involving the learners, the outcomes and longer-term consequences of the practice would be more sustainable and as these learners would be impacted with the consequences of what was done over the academic year and for learners coming after them. The research then becomes about empowering the learner while focuses on that individual learner (McNiff, 2002).

Linked to this is the recognition that my research approach had the characteristics of Argyris's notion of double-loop learning (Argyris, 1977). Double-loop learning (also discussed in the next section) goes beyond single-loop learning and involves questioning the underlying assumptions behind techniques, goals and values (Argyris, 1976). Double-loop learning uses feedback from past actions to question assumptions underlying current views. This is a skill that is essential for higher-order problem-solving and leadership. It is the ability to question and change the rules of a game.

While this research is a relatively short-term and technical intervention, there is reflection-in-action and reflection-on-action (Schön, 1987) and the aim is to understand and interpret social situations with a view to their improvement. In this case, the social situation was the learning environment, both in-class and out-of-class. By its nature, research in learning environments cannot be too individualistic and must consider wider curriculum structures, regarding teachers in isolation from wider factors (Elliott, 1991, p. 55). Like practical action research, the double-loop learning draws on the researchers and the learners' informed judgement to enable both parties to act more wisely (Grundy, 1997; Kemmis, 2009). As the saying often attributed to Einstein goes, "We can not solve our problems with the same level of thinking that created them," and with this in mind I was careful to make sure the focus was not solely on gaining efficiencies, but more about research and development of the various elements of the research. I was conscious that I could have gotten into a cycle of reflection and problem posing and a preoccupation with operational thinking rather than strategic thinking and practice.

A learning environment can be understood as a complex ecosystem, which further supports the suitability of action research as an approach for studying it. As Phelps and Graham (2010) observe, action research acknowledges that systems are unpredictable, open, and non-linear. It embraces the interactions between participants, incorporating both feed-back and feed-forward mechanisms to foster continuous improvement. Light (2008) similarly highlights that action research is not primarily concerned with controlling variables, but rather with understanding and responding to the complexity and dynamism inherent in the systems within which it operates.

The Role of Action Research in Improving Practice

Elliott (1991, p. 49) states that the main aim of action research is "to improve practice." As this research involved examining my own educational practices and taking action to try and improve those practices, action research was a good fit. The initial intervention

of introducing an online quiz into my teaching and the creation and refinement of subsequent quizzes coupled with various attempts to improve participation were all attempts to change and improve my practice over time. Kemmis (2009, p. 463) suggests that action research changes people's practices, their understandings of their practices, and the conditions under which they practice. Hopkins (1993) asserts that the combination of action and research renders that action a form of disciplined inquiry, in which a personal attempt is made to understand, improve and reform practice.

As outlined in Chapter 1: Introduction, over the previous few years, I had identified several pedagogical challenges with certain modules. In action research, this initial identification of challenges is referred to as the reconnaissance phase, during which the researcher gathers information to establish that there is a problem or challenge to be addressed (Kemmis & McTaggart, 1988). This phase, described in Section 4.3.4, informed my decision to use action research as a suitable vehicle to explore solutions to these challenges and to deepen my understanding of assessment for learning, particularly in the context of large groups. An objective of this research journey was to better understand my own practices and the environment in which I work, with the aim of continual improvement. While this is the goal of many educators, I had a specific focus that required a rigorous process for investigation.

Action research provided a systematic and rigorous way to conduct this investigation, going beyond what typically occurs in daily practice (Kemmis & McTaggart, 1988, p. 10-14). Kemmis and McTaggart (1992, p. 21–2, cited in Cohen et al., 2018, p. 442) distinguish action research from the everyday actions of teachers: in four main ways:

1. It is thinking in a more systematic and collaborative way than the customary, everyday ways in which teachers consider their own practices.
2. It moves beyond problem solving alone to identifying and raising problems, regarding problem solving as opportunities for change, learning and improvement rather than as simply curing ills.
3. It involves participants working on their self-identified areas of work, i.e., it is owned by the participants rather than external researchers.
4. It adopts a heterogeneous rather than unitary concept of the science of teaching.

Each of these four points is directly relatable to my own research and the purposeful intent, higher level of enquiry and relationship with participants sets it apart from

everyday practice. The subsequent analysis of findings and documentation of the whole process further distinguish action research from daily practice.

For me, the reasons for engaging in research and why action research is particularly suitable align closely with the motivations that Somekh and Zeichner (2009) propose in their *Dimensions of Variation in Action Research*. They describe the motivation to better understand and improve one's practice and/or the contexts in which one works and also the motivation to produce knowledge that will be useful to other educators. This leads on to my view of myself as both an educator and researcher. Somekh (1995, p. 340) points out that the "action research methodology bridges the divide between research and practice," and " … addresses the knotty problem of the persistent failure of research in the social sciences to make a difference in terms of bringing about actual improvements in practice." Furthermore, Elliott (1991, pp. 51–54) points out that, by philosophically and ethically reflecting on their educational practice through action research, educators should be in a position to improve your practice, realise their values as educators, contribute positively to curriculum development and add to the theory of education which is accessible to others.

While the primary goal was to improve both practice and student learning, it was also crucial to consider the time and energy required for the intervention. For other educators to adopt similar strategies, the intervention needed to be both effective and practical. The findings had to demonstrate sufficient impact without requiring excessive effort, ensuring they were feasible and sustainable for broader implementation.

Self-Reflection

This research was as much about my professional development as an educator as it is about the learners, or the pedagogical strategies employed. Therefore, self-reflection was an important principle during the research and again fits with the action research approach. McNiff and Whitehead (2011) describe how action research combines diagnosis, action and reflection. They suggest that in some forms of research, the researcher does research on other people, whereas in action research, the researcher does it to themselves. This is key to Zuber-Skerritt (1996) assertion that action research is as much about the educator better understanding their own practices, as it is about practical improvements or innovations. Kemmis and McTaggart (1988) view action research as a type of critical reflective enquiry which participants undertake on and for themselves, focusing on problems and practices which they identify themselves and

which affect them, with the intention of understanding and improving the educational and social practices in which they are involved and the circumstances in which they take place. (Cohen et al., 2018a). From the outset, a goal of this research was to improve my understanding of my own practices in terms of learning, assessment, TEFA, curriculum design. Action research facilitated the possibility of researching these elements of my own practice as well as researching the learners. The self-reflective enquiry aspect to the research provides for a deeper understanding of these areas.

In this research I did not remain a passive, detached observer. Instead, I was also an active participant. Therefore, the concept of reflexivity was central to the self-study. Reflexivity is the process of examining both yourself as researcher, and the research relationship with the learners to provide more effective and impartial analysis. The key to reflexivity is to make the relationship between and the influence of the researcher and the participants explicit (Jootun et al., 2009, p. 45). They note that educators should be engaged on a daily basis in reflexivity and reflective practice, but this research approach helps to formally shift the focus to the "teacher-as-researcher" (Elliott, 2007) with a view to getting a more rounded set of findings. Whitehead et al. (2020) also highlights the importance of self-study and how that is more likely to positively change and improve our practices than merely reading about what someone else has discovered of his teaching. It is important to clarify that when I refer to self-study, I am using it in the context of self-reflection as a reflexive activity, rather than in its more formal methodological sense.

Transformational Nature of Action Research

Elliott (1991, p. 49) highlights how action research "… transforms rather than simply preserves the old professional craft culture of teachers." In *Educational Action Research as Transformative Practice*, Brydon-Miller et al. (2017) also argue how education can be a transformative practice for the learner and the researcher/practitioner. This research aimed to explore the extent to which the intervention could lead to such transformations for both myself and the learners. The subsequent chapters present the findings and assess the success of the intervention in achieving these transformative outcomes.

The theme of transformation is central throughout Freire's *Pedagogy of the Oppressed*. Freire (1972) talks about revolutionary transformation and proposes ways to transform the world of oppression, ways of perceiving reality, culture, society, institutional structures, behaviour, people's view of the world, and their ethics. What resonated with

me was his thesis that education is key in these transformations. On a practical level, he details how educational transformation can happen in universities through the use of dialogical teaching, not merely as a method, but as a way to create a process of learning and knowing, to foster the development of the teacher-student relationship, and to integrate theory and practice, reflection and action. He also substitutes the word transformation for development and suggests that we should "see the world not as a static reality but as a reality in the process of transformation," and how education is an ongoing activity. As Macedo points out in his introduction to Freire's publication (Freire, 2000, p. 25), "as the term "pedagogy" illustrates, education is inherently directive and must always be transformative."

An ultimate goal for any educator, certainly for me, was articulated in some findings from a study by Pine (2009). The study documented the transformative power of action research in changing teaching approaches, and how the teachers reported developing a deeper understanding of their students and of who they were as teachers, in enhancing their confidence and self-esteem, in gaining new perspectives, and in revitalising their careers. They affirmed that teacher action research was a valid and energising process for constructing knowledge about teaching and learning and for empowering teachers to take leadership in bringing about educational change. This is such a significant and powerful finding for me as this type of level of transformation is almost like 'the holy grail' for educators.

Finally, I believe the introduction of technology in an educational setting can have a transformative effect on a student. A topic I teach in some of my technology and business modules is the effect that technology can have on an organisation. These effects range from small efficiencies through automation to paradigm shifts that can radically change the entire business model. I recognise that I likely hold a techno-positive outlook, viewing technology as an inherently transformative tool in both education and organisational contexts. This outlook is common among educators, as noted by Ryan et al. (2020), who describe techno-positivity as the uncritical embrace of technology as a solution to educational challenges, often overlooking its complexities and limitations. The Joint Information Systems Committee UK (JISC, 2009) echo this possibility of transformation in education through technology, suggesting that combining "technology-enhanced options with the best of established practice...has greater capacity to create meaningful and transformative learning experiences," (p. 16).

Link between Formative Assessment and Action Research

In the Literature Review in Chapter 2, formative assessment is explained and discussed in relation to this research. The cyclical, reflective nature of formative assessment, where feedback informs ongoing improvements, mirrors the iterative cycles of action research, making the two approaches highly compatible (McNiff and Whitehead, 2011). This section highlights the synergy between formative assessment and action research. This synergy was a major factor in choosing the action research approach for this research.

Linking to the section above on continuous professional development, McNiff (2002) explains how formative (ongoing) assessment monitors this kind of professional incrementalism allowing practitioners to evaluate and modify their actions as appropriate, which can lead to them developing and transforming past practice in new contexts.

Torrance and Pryor (2001) state that the action research approach seems particularly suited to high-quality development work on the interface between teaching, learning and assessment, particularly when developing formative assessment in the classroom. Action research has contributed greatly to this research mainly because the area of formative assessment/assessment for learning is particularly amenable to the methodology adopted. Stobart (2008) argues that assessment shapes how we see ourselves as learners and as people. He takes an incrementalist approach to learning which emphasises effort and improving competence. Again, this fits well with the action research approach. Yorke (2014) found that formative assessment is vitally important to student learning and how it is fundamentally a collaborative act between staff and student whose primary purpose is to enhance the capability of the latter to the fullest extent possible. I used formative assessment to enhance my own pedagogical practice. Given the formative assessment angle to my research, action research was an obvious approach for me. I viewed action research almost like using a formative assessment approach for my students. In each cycle, I would create quizzes and then review feedback from my students as to how I could improve each quiz and how I could get them to engage better with the quizzes. Armed with this information and learning from other sources, I would try to create an improved quiz, release that quiz and then, once again, searched for feedback. Action research was a vehicle for learners to generate

formative feedback for me in order for me to improve my classroom assessment practices.

According to Stobart (2008), whose definition of assessment for learning (AfL) closely aligns with my definition of formative assessment, the emphasis is placed on the situational-classroom interaction rather than on individual learner dispositions. In contrast to theories on intelligences and learning approaches, Stobart's approach puts its focus on what is being learned and on the quality of classroom interactions and relationships. His approach is about gathering evidence about where learners are and providing feedback, which helps them move on. While my interactions would not necessarily happen within the traditional classroom, but more within the virtual classroom, the evidence came from observation of these online activities and interactions and from requesting feedback from the learners. The quiz attempts introduce an important part on the feedback loop for me, as the responses were used to identify what had, and had not, been understood, and how I could change my practice to further improve their learning.

Continuous Professional Development

McNiff (2002) highlights how action research can drive professional development by encouraging practitioners to systematically reflect on and refine their practice. Cohen et al. (2018, p. 442) add that that action research is "situated learning: learning in the workplace, about the workplace and for the workplace." Although this explanation seems to have an internal focus, if this is done on an ongoing basis and is coupled with external research and knowledge this is real learning and is essentially continuous professional development.

Following on from the notion of self-study and the teacher-as-practitioner, Hogan et al. (2007, p. i) suggest that "whole-hearted engagement with well-designed continuing professional development activity can be a catalyst that unleashes new energies, fosters fresh enthusiasm, cultivates deeper understanding and fine-hones pedagogic skills." They state that if the teacher is also the researcher, problem identifier and solution provider, then it is clear how the action research process can be seen to enable professional development.

Hogan et al. (2007, p. 8) also highlight the "insularity," of a teacher's professional life, which is "often a self-protective one," and how professional development can not only help improvements in practice, but the sharing of those ideas with other staff can have

a very beneficial effect on the educator and the workplace culture. For me, there are two things that illustrated this "insularity." Firstly, on a typical business programme, my experience is that there is a definite sense that educators work in their own silo with their own module(s). This limits the sharing, especially if there is not a culture of collaboration within an institution or department. Secondly, in third level education, it is highly unlikely that there will ever be anyone else in your classroom apart from you, the lecturer, and your students. I noticed this as part of my MA in Learning & Teaching, when having a critical friend observe and give feedback on my teaching was a strange experience. In this study, while I did not engage with a single, permanent critical friend, I benefited from the support of several individuals who contributed as critical friends across various facets of my research. I consulted with one colleague specifically for refining ethical approval processes and addressing ethical concerns, another for the technical aspects of integrating technology, and additional colleagues for insights into pedagogy. My supervisor also provided critical feedback throughout the entire action research process, acting as a consistent source of reflection and challenge. This collaborative input supported my practice and reflective process, even though no single individual fulfilled the role of a dedicated critical friend for the entire duration of the study.

Noffke (1997, p. 306) acknowledges the importance of generating professional knowledge, stating that the main benefits of engaging in action research lie in "greater self-knowledge and fulfilment in one's work, [and] a deeper understanding of one's own practice." This is particularly relevant to my experience in this research, where action research has not only helped me refine my teaching practices but has also fostered a deeper awareness of my role as an educator. By systematically reflecting on my practice, I have been able to identify areas for improvement and create more effective learning experiences for my students, demonstrating how action research serves as a powerful tool for ongoing professional development.

4.2.2. Action Research Steps

The clear and applied nature of the work of Kurt Lewin, John Elliot, Jean McNiff and Jack Whitehead (Elliott, 1991; McNiff & Whitehead, 2011) were part of the reason why I chose the action research approach in the first place. Their uncomplicated, practical steps made sense to me and gave me a workable blueprint to follow. Later, the work of David Coghlan (Coghlan & Brannick, 2014) also resonated, not only because of his

focus on organisational and business contexts, which aligned with my own background, but also due to the adaptability of his approach within educational settings. Over time, my action research steps evolved, partly out of necessity and partly to better align with this specific educational research.

This section brings together the main authors and models that inspired me and culminates with the module that I finally followed though my action research cycles. I outline the methodological steps I took while also showing how my steps emerged from a variety of models. This showcases the originality of my approach, stating clearly exactly what it is, and demonstrates my understanding of the different models that underpin my final approach.

Lewin (1946, 1948 as cited in Cohen et al., 2018, p. 448) codified the action research process into four main stages: planning, acting, observing and reflecting. Elliott (1991) also describes how this operates in a cyclical process, with one cycle of this four-step approach leading into the subsequent four-step cycle. There are several ways in which these steps in action research have been analysed. According to McNiff (2002), the basic steps of an action research process constitute an action plan for educators–we review our current practice, identify an aspect that we want to investigate, imagine a way forward, try it out, and take stock of what happens. We modify what we are doing in the light of what we have found and continue working in this new way (try another option if the new way of working is not right) monitor what we do, review and evaluate the modified action, and so on.

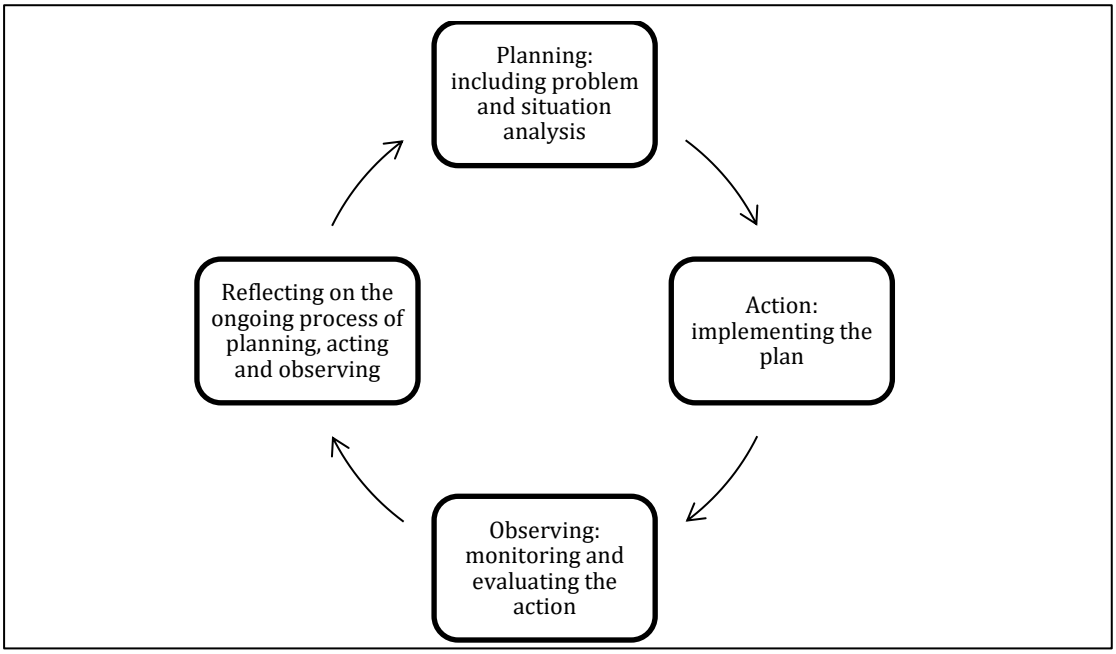


Figure 5. Action Research Cycle (Elliott, 1991)

A slight adaptation of this model, which helped guide this research was by The New South Wales Department of Education and Training (2010) (see Figure 7 below), who suggest some extra steps between each of the four steps shown above. They suggest that: in between planning and acting come identifying, informing, organising; between acting and observing come trialling, collecting, questioning; between observing and reflecting come analysing, reporting, sharing; between reflecting and the new cycle comes planning, evaluating, implementing, revising. Piggot-Irvine et al. (2015) highlight the fact that action research is inherently continuous, with each cycle naturally flowing into the next, rather than having a clearly defined conclusion.

Lewin (1946, 1948) suggests that action research commences with a general idea and data are sought about the presenting situation. The successful outcome of this examination is the production of a plan of action to reach an identified objective, together with a decision on the first steps to be taken. Lewin acknowledges that this might involve modifying the original plan or idea. He notes that the next stage of implementation is accompanied by ongoing fact-finding to monitor and evaluate the intervention, i.e., to act as a formative evaluation. This feeds forward into a revised plan and set of procedures for implementation, themselves accompanied by monitoring and evaluation. Lewin (1948, p. 205) suggests that such "rational social management" can be conceived of as a spiral of planning, action and fact-finding about the outcomes of the actions taken.

Coughlan and Coghlan (2002) say that the AR cycle comprises three types of steps. First there is a pre-step, to understand context and purpose. Then there are the six main steps: to gather, feedback and analyse data, and to plan, implement and evaluate action. Finally, there is a meta-step to monitor. These three steps added another dimension to each cycle. The first step helped me focus on understanding the learning environment, the groups of learners involved and what exactly I was trying to achieve before each cycle started. This is a preparation cycle before entering the field and starting into the first cycle with its main steps. I add this first pre-step step into Figure 7 below as a starting point for each of my research cycles.

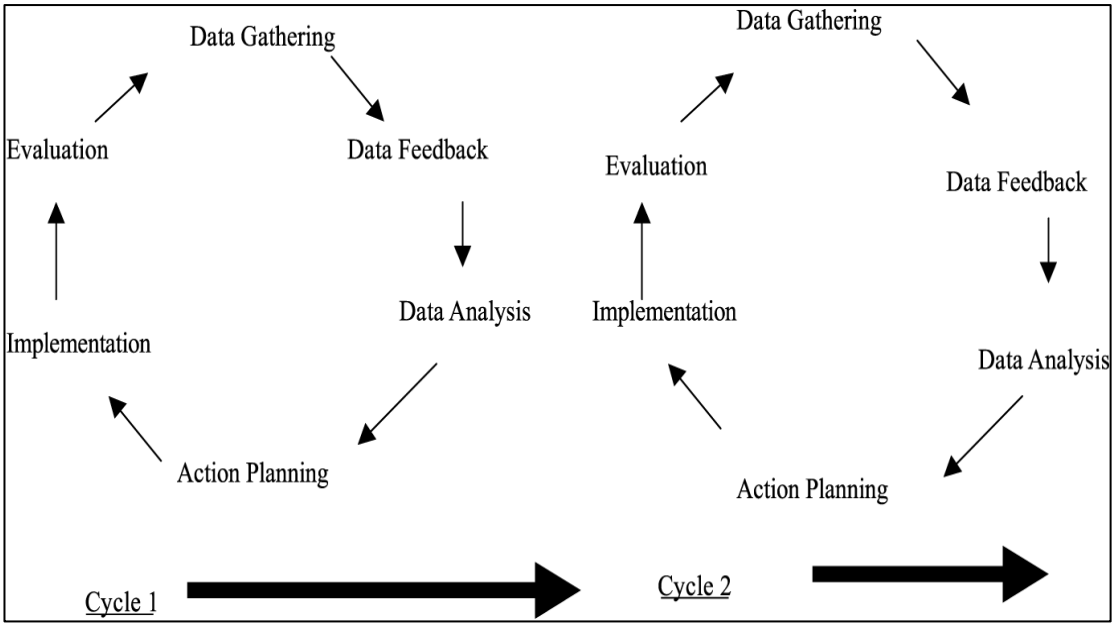


Figure 6. Action Research Cycles (Coughlan and Coghlan, 2002)

The action research cycle diagram, as depicted here, bears similarities to strategic planning processes, which initially appealed to me given my background in business and IT. However, the primary reason for adopting this model lies in its transformative potential within an educational context, aligning well with the iterative nature of action research and my research objectives. Unlike traditional strategic planning, which may not always aim for transformational outcomes, this action research model supports ongoing improvement and adaptation (Coghlan & Casey, 2001). Furthermore, it serves a dual purpose: not only does it facilitate improvements in practice, but it also contributes to the broader body of knowledge by formalising the research process, enabling knowledge-sharing, and enriching professional dialogue.

McKernan (1996) notes that Lewin's model of action research is a series of spirals, each of which incorporates a cycle of analysis, reconnaissance, reconceptualisation of the problem, planning of the intervention, implementation of the plan and evaluation of the effectiveness of the intervention. (Ebbutt and Elliott, 1998) adds that feedback within and between each cycle is important, facilitating reflection.

Figure 7. Final Version of Action Research Cycle

(NSW Department of Education and Training, 2010) [Modified for this study]

(Note: Context and purpose, content process premise, red lines/arrows added for this study)

Coghlan (2006) highlights how first-person inquiry/practice encourages researchers to act in ways that are informed, aware and purposeful. I added the Context and Purpose box to signify the important step of understanding the teaching and learning context and identifying the purpose of the next research cycle before the cycle begins.

I have added the red lines above to show that I had obtained feedback within each cycle as well as feedback between each cycle. This illustrates that feedback happens throughout each cycle and not just at the end of the cycle. Coghlan (2006) further influenced this diagram where I have added the three pillars of content, process and premise reflection, which are part of the learning process, building on from Mezirow (1991). Coghlan explains that in an organisation, content reflection is where executives think about the issues, what is happening, etc., process reflection is where they think about strategies, procedures and how things are being done, and premise reflection is where they critique underlying assumptions and perspectives. All three forms of

reflection play a significant role, which is why I have included them in this final version of my action research process.

It should be noted that this model would link to another iteration of the same model and would repeat for the next cycle. McKernan (1996) notes that action research uses feedback from the data in the first cycle in an ongoing cyclical process. As mentioned earlier, this iterative nature is also highlighted by Kemmis and McTaggart (1988), who describe the action research spiral as a series of cycles involving planning, acting, observing, and reflecting. Hatten et al. (1997) emphasise that single-loop learning can become unproductive, highlighting the necessity of progressing to the next iteration for continued effectiveness., a concept further supported by Argyris and Schön (1978) who advocate for double-loop learning to question and modify underlying assumptions and not letting single-loop learning keep us in an infinite loop. Like the Coghlan diagram in Figure 6, this process follows a cycle of continuous improvement. Once one cycle is completed, it naturally leads into a new iteration of the same model. This ensures ongoing refinement and improvement of both practice and understanding, allowing each cycle to build on the insights and outcomes of the previous one.

4.3. Research Methods

This section describes the research location, the participants involved, and the action research process undertaken over a two-year period. This study employed both quantitative and qualitative methods, a combination chosen to capture a comprehensive view of student engagement and learning experiences. Quantitative data, such as quiz participation, attendance records, and exam results, provided a broad view of student engagement trends, while qualitative insights from surveys and focus groups helped contextualise these patterns, offering a deeper understanding of student perspectives.

Diverse data collection methods were used in this study. Surveys were instrumental in gathering student feedback on the development and effectiveness of the quizzes, capturing the student voice and facilitating collaboration between learners and myself in co-designing the quizzes. Learner analytics, including quiz, attendance and general engagement metrics were collected from the virtual learning environment (VLE) to measure ongoing engagement in the modules. Examination results were also used to track academic achievement. Observational notes were used to systematically document actions, student behaviours, and responses during each research cycle, providing real-time insights to inform ongoing adjustments to the interventions.

The rationale for the choice of data collection techniques and data sources, and critiques by various authors in previous academic papers are included below to illustrate a fully comprehensive understanding of the different research methods. As this inquiry involved investigating the experience of a large group of undergraduate students, the research was exploratory and open-ended.

According to Corbin and Strauss (2008, p. 12), the voices and actions of the participants are central in constructivist research. Their view is that qualitative methods allow researchers to get at the inner experience of participants, to determine how meanings are formed through and in culture, and to discover rather than test variables. From this perspective, qualitative methods of enquiry are essential to attempt to capture the uniqueness of the individual and quantitative methodologies are more constrained in what they can contribute to understanding experience. However, Hardiman (2012) argues quantitative methods are valuable for contextualising these experiences within broader trends, enabling a more complete understanding when used alongside qualitative data. Focus groups were employed at the end of the semester for an in-depth exploration of learner issues, building on initial insights gained from the quantitative and qualitative data gathered throughout the semester. This combined approach aligns with Creswell's (2014) assertion that diverse data types, when used together, provide a fuller understanding of the research problem than either quantitative or qualitative data alone.

4.3.1. Research Location

The research took place in my own Higher Education Institution (HEI-A), a key provider of higher education in the northeast region of Ireland. HEI-A serves a diverse student population, primarily from the surrounding counties. The institution has evolved from a Regional Technical College to a technological institute offering a range of undergraduate and postgraduate programmes.

A significant proportion of HEI-A’s learners are the first in their families to attend college or higher education. Over the past five decades, HEI-A has made a substantial contribution to the region, particularly through its support of first-generation learners (HEI-A Strategic Plan, 2016). This has opened new opportunities for families and communities, reinforcing the institution’s reputation as a welcoming and inclusive campus. The student population reflects the diverse socioeconomic backgrounds of the region, with many students coming from disadvantaged areas. While specific

demographic data were not collected for this research due to ethical considerations, which are explained in the 4.5. Ethical Considerations section later in this chapter, my observations suggest that these characteristics are reflected and consistent with the student groups I worked with. This context of supporting first-generation and disadvantaged learners shaped the educational challenges I sought to address through this action research project.

4.3.2. Research Participants

The selection of the groups for this research was based on their enrolment in a specific module that I led, which aligned with the research objectives and allowed me to investigate and reflect on my own teaching practices. These groups were all from the same year and were taking the same module, which facilitated a consistent and controlled comparison of engagement and learning outcomes. Additionally, all chosen groups attended the same lecture for the theory element, making it the largest class in the college at the time. I had taught this module for the previous five years, and the group was consistently large. As discussed in Chapter 1: Introduction, with a heavy emphasis on the end-of-semester theory exam, and limited autonomy to adjust the weighting between continuous assessment (CA), a practical lab-based spreadsheet modelling task worth 30%, and the final exam, which was worth 70%, this group was expected to present the most challenges. However, both my observations and initial reconnaissance, which I present later, indicated that they would benefit most from the intervention.

The decision to focus on this particular year and semester was influenced by the fact that it was my largest class, comprising students from three different programmes. I also knew I would be teaching this cohort again the following semester, which allowed me to continue implementing and evaluating the intervention across the full academic year. Furthermore, I was planning a third action research cycle with the following year's cohort, who would study the same content and be assessed in the same way, enabling comparisons across different student groups. This approach ensured that each cycle of action research could build on the findings of the previous one, allowing for iterative improvements and adaptations to the formative assessments. Additionally, I was teaching another group in the first cycle who were studying similar content but did not have access to the quizzes. Although this group was not part of the intervention initially, their engagement data provided a baseline for comparison against the primary research

group in Action Research Cycle 1 (ARC1). In the following semester (ARC2), this group became part of the intervention, allowing for an expanded application of the approach.

Action Research Cycle 1

Action Research Cycle 1 (ARC1) involved the following three class groups. These class groups were all taking the same module and were together in the same large lecture hall, for two lectures per week. The groups were:

- Programme A: 56 students
- Programme B: 49 students
- Programme C: 13 students
- Total number of students: **118 students**

In this research cycle, a comparison group (Programme D with 71 students) was included to provide baseline engagement data against the primary research group. While this group studied some similar content, they did not have access to the quizzes. Ethical considerations for their inclusion are discussed in Section 4.5, but in short, this cycle focused on building and evaluating the effectiveness of the intervention, so no proven benefits were withheld from the comparison group.

Action Research Cycle 2

Based on the analysis of survey responses and focus groups in ARC1, quizzes were developed for use in Action Research Cycle 2 (ARC2) the following semester. For ARC2, all of the student groups above were included and a second cohort studying a similar module on a different programme was introduced. This group was the comparison group in the first research cycle. Consequently, there were four groups involved in this action research cycle. Like ARC1, the first three class groups below were all together in the same room for the two lectures per week and a second cohort studying a similar module on a different programme was introduced. The Level 8 students studied Module B and the Level 7 students studies Module C. These modules had four out of five of the same content topics. The groups involved were:

- Programme A: 56 students
- Programme B: 49 students
- Programme C: 13 students
- Programme D: 86 students
- Total number of students: **204 students**

Action Research Cycle 3

Action Research Cycle 3 (ARC3) took place in Semester 1 of the next academic year. The participating class groups were all taking the same module and were together in the same room for two lectures per week. Although the modules were from the same year and programme as the year before, the students were different, because the previous students had progressed to the next year of their programme. These groups were the next cohort of students on those programmes. The groups were:

- Programme A: 49 students
- Programme B: 41 students
- Programme C:11 students
- Total number of students: **101 students**

4.3.3. Research Process and Timeline

The research took place over three semesters spanning two academic years. The timeline for designing and releasing the quizzes and the participant involvement in surveys and focus groups are shown below. This can be seen with more detail in Appendix C: Summary of Action Research Cycles.

Action Research Cycle 1

The timeline of the first research cycle is as follows:

- ARC1 Week 0: Start-of-Semester/Pre-intervention survey
- ARC1 Week 6: Design and publish Quiz 1 (Reading Week)
- ARC1 Week 6: Design and publish Quiz 2 (Reading Week)
- ARC1 Week 9: Mid-intervention survey
- ARC1 Week 9: Design and publish Quiz 3
- ARC1 Week12: Design and publish Quiz 4
- ARC2 Week 3: Post-intervention survey
- ARC2 Week 4: Post-intervention focus group (Led by an independent moderator)

ARC1 took place in Semester 1 of the academic year, however, the end of semester survey and focus group took place near the start of the next semester. The rationale and ethical consideration behind these dates are explained in Section 4.5 Ethical Considerations.

Action Research Cycle 2

The timeline of the second research cycle is as follows:

- ARC2 Week 6: Design and publish Quiz 1
- ARC2 Week 10: Design and publish Quiz 2 (Easter Break)
- ARC2 Week 14: Design and publish Quiz 3
- ARC2 Week 15: Design and publish Quiz 4 (Semester Ends)
- ARC2 Week 15: Design and publish Quiz 5 (Semester Ends)
- ARC2 Week 23: End of Semester Survey
- ARC2 Week 23: End of Semester Focus Group

Action Research Cycle 3

The timeline of the third research cycle is as follows:

- ARC3 Week 5: Design and publish Quiz 1
- ARC3 Week 6: Design and publish Quiz 1
- ARC3 Week 9: Design and publish Quiz 1
- ARC3 Week 9: Design and publish Quiz 1
- ARC3 Week 9: Mid-intervention survey
- ARC3 Week 14: Design and publish Quiz 1
- ARC3 Week 23: End of Semester Survey

4.3.4. Reconnaissance: Preliminary Expert Consultations

In the initial phase of this research, expert consultations were conducted to gather insights and deepen understanding in key areas relevant to the study. These informal, exploratory consultations ensured the research questions and interventions were grounded in the practical realities of educational reform and technological implementation, making the study both timely and relevant. I consulted with individuals involved in educational reform and curriculum development within the policy-making sector, gaining perspectives from professionals shaping instructional materials in the educational publishing sector. I also gathered insights from leaders in the assessment technology sector on the development and implementation of computerised testing systems in both high- and low-stakes environments. These consultations provided diverse viewpoints across key areas of education and technology, offering a foundational understanding that guided the subsequent phases of the research.

According to Cohen et al. (2018), face-to-face consultations are particularly effective in establishing rapport with participants, increasing the likelihood of securing high-quality information. This was essential in the exploratory discussions in this current study, where the informal setting encouraged an open exchange of ideas. As Bernard (2011) suggested, the flexibility of these conversations allowed the experts to share their perspectives candidly and without the constraints of rigid questioning, which was crucial for exploring complex topics such as the future of assessment and the role of technology in education.

These consultations had two key purposes: they helped clarify and refine the research process and also shaped the development of the research questions. The insights gathered were instrumental in identifying relevant themes and issues that were not immediately obvious to me. This ongoing process of reflection and learning ensured that the research questions were grounded in practical realities.

Conducted over the first year of my doctoral programme, these consultations were not recorded. Instead, I took detailed notes, which were later reflected upon to extract key insights. Since these conversations were primarily for fact-finding and exploratory purposes, rather than formal data collection, ethical approval was not needed. In the policy-making sector, I consulted with individuals involved in educational reform and curriculum development. From the educational publishing sector, I gained insights from professionals developing instructional materials, such as textbooks and digital learning tools. Additionally, consultations with leaders in the assessment technology sector provided valuable perspectives on the development and implementation of computerised testing systems in both high and low-stakes educational environments. While these expert consultations were not part of the formal dataset for analysis, they played a key role in shaping both the research questions and the selection of the data gathering instruments described in the next section.

4.3.5. Data Gathering Instruments

Building on the insights gained from the expert consultations in Section 4.3.4 and drawing on the Participatory Action Research framework discussed in Section 4.2, this study employed a variety of formal data-gathering methods to investigate student engagement and learning outcomes in the TEFAs. These methods were chosen to ensure that both quantitative data and qualitative data were captured. By combining measurable

outcomes with personal insights from participants, the study gained a holistic understanding of my educational interventions.

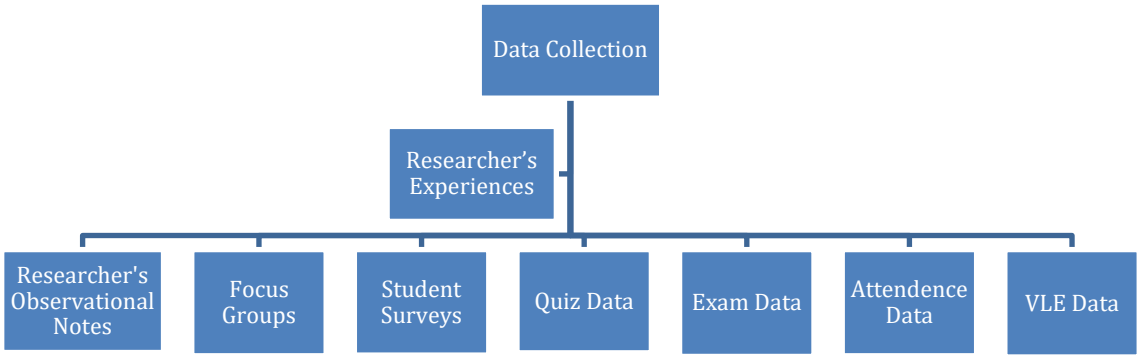


Figure 8. Summary of Data Collection Methods

Figure 8 above, illustrates the methods of data collection used for this study, which included observational notes, focus groups, student surveys, quiz data, exam data, attendance data, and VLE logs. These methods were chosen to ensure a comprehensive and triangulated approach to understanding student engagement and learning outcomes.

The rationale behind using multiple data gathering methods was grounded in the principle of triangulation, which involves examining the research problem from different perspectives to enhance the validity and credibility of the findings. Greene et al. (1989) described triangulation as a process of cross-verifying data by employing multiple methods to study the same phenomenon. In this study, triangulation was achieved by enriching quantitative data, such as survey responses and exam results, with qualitative insights from open-ended survey questions, focus groups, and reflective journals. For example, survey data offered broad insights into student engagement with quizzes, while focus group discussions provided detailed qualitative feedback about specific features of the quizzes that enhanced or hindered learning. The interplay between these methods added depth to the findings, helping to explain trends observed in the data and uncovering factors that influenced student engagement and academic success.

The use of multiple data gathering tools also aligns with the participatory nature of the research. As a core component of PAR, the active involvement of participants in providing feedback and reflecting on their learning experiences was central to the study (Cohen et al., 2018a). The qualitative feedback from focus groups and reflective journals did not just complement the quantitative data, it was essential in shaping the ongoing research cycles by informing adjustments to the interventions. This

participatory approach ensured that the research was rigorous and grounded lived experiences of the participants, making the findings both meaningful and relevant to the study context.

Through the integration of these diverse data collection methods, the research aimed to produce findings that were reliable, reflective of varied student experiences, and useful for informing future educational practices. The following sections will explain each of the methods used, outlining how they contributed to the overall research process and supported the iterative cycles of action research.

Surveying the Participants

The decision to employ surveys as a primary data collection method in this research was driven by the need to systematically capture and analyse students' experiences, perceptions, and attitudes towards the educational interventions, particularly the use of quizzes. Surveys offer a structured and efficient approach to gathering data from a large number of participants (Cohen et al., 2018), which was crucial for capturing the diverse perspectives within the student body. They are especially suited to exploring the effectiveness of specific educational tools such as quizzes, providing broad and in-depth insights into aspects such as student engagement and perceived learning benefits (Bryman, 2008).

Surveys were integral to the iterative nature of this action research study. Administering them at strategic points during the semester, namely mid-semester and at the end of the semester, enabled the collection of rapid feedback, which could inform adjustments to the interventions in real time. For instance, mid-semester surveys revealed critical insights into student interactions with quizzes, leading to timely improvements in quiz design and delivery. End-of-semester surveys, in contrast, captured more reflective feedback on the overall impact of quizzes on student learning and engagement.

The design of the surveys was informed by established survey design principles (Oppenheim, 1992) and adapted from validated user experience instruments such as the User Experience Questionnaire (UEQ) (Laugwitz et al., 2007) and elements of the NASA-TLX (Hart, 2006). These instruments provided a solid framework for measuring the usability and cognitive load associated with the quizzes, respectively. For example, contrasting attributes from the UEQ, such as "boring–engaging" and "helpful–useless" were adapted to assess students' perceptions of the quizzes. Similarly, NASA-TLX inspired items such as "easy–demanding" were included to gauge the cognitive effort

required to complete the quizzes. These instruments were adapted to fit the educational context of this study, focusing on quiz characteristics relevant to student engagement and learning. For instance, while the original UEQ was designed for general user experience assessment, this study adapted its contrasting attributes to reflect specific educational dimensions, such as the relevance and clarity of quiz content. Additionally, the wording of some items was simplified to ensure accessibility for a diverse cohort of undergraduate students, many of whom were unfamiliar with survey instruments designed for technical or usability studies. The adaptations preserved the reliability and validity of the original instruments while tailoring them to the unique needs of this research.

The surveys included a balanced mix of closed and open-ended questions. Closed questions facilitated straightforward analysis and comparison, allowing for the quantification of student perceptions across key themes such as quiz usability, relevance, and engagement. Open-ended questions, on the other hand, provided students with the opportunity to share detailed feedback, offering qualitative insights that complemented the quantitative data. This mixed-methods approach ensured a comprehensive understanding of students' experiences with the quizzes.

To maximise participation, surveys were distributed electronically via an online platform and in paper format. This dual approach gave students the flexibility to choose their preferred method, increasing response rates. Reminders were sent through email and reinforced via in-class announcements, ensuring timely responses and enhancing the relevance of the data collected.

All students enrolled in the modules involved in each ARC were invited to participate in the surveys. Paper-based surveys were distributed during class sessions, meaning all students present on the day of administration had the opportunity to provide feedback. For the online surveys, links were emailed to the entire class, ensuring that every student, irrespective of their attendance on specific days, had an equal opportunity to participate. This comprehensive sampling approach aimed to capture diverse student perspectives and maximise representativeness within the survey data.

Ethical considerations were central to the use of surveys and are detailed further in Section 4.5 below. Students were informed about the purpose of the surveys, assured of their anonymity, and provided with clear explanations of how their feedback would be used to improve educational practices. This transparency was crucial for building trust

and encouraging honest responses, contributing to the overall reliability of the data collected. More details on the surveys administered for ARC1, ARC2 and ARC3 can be seen in Appendix D: Surveys.

Virtual Learning Environment (VLE) Logs

The integration of Virtual Learning Environment (VLE) was essential in tracking and analysing student engagement across each semester. VLE platforms such as Moodle automatically log a variety of student activities, including the frequency of logins, time spent on quizzes, assessment grades, and interactions with feedback. This comprehensive dataset enabled an objective, real-time analysis of student behaviour within the digital learning environment. Learning analytics, defined as the process of collecting, interpreting, and acting on data from IT systems to support student learning (Tsai et al. 2018), provided a theoretical foundation for using VLE logs in this research. As highlighted in the (Y1Feedback Report, 2016), learning analytics offer the ability to identify patterns, understand problems, and inform targeted interventions. Within this study, VLE logs were particularly useful in monitoring how students accessed course materials and engaged with the TEFAs. Unlike self-reported data, which can be prone to bias, VLE logs provided precise, reliable records that enhanced the validity of the findings.

The data gathered from the VLE allowed for identifying trends that indicated either strong engagement or potential disengagement. For example, students with frequent logins and significant time spent reviewing feedback often demonstrated high engagement, while minimal activity highlighted lower engagement levels. These insights, coupled with other data sources such as surveys and focus groups, informed timely adjustments to the course design to better meet students' needs. The ability to analyse these interactions aligns with the goals of predictive analytics, which aim to identify at-risk students and implement proactive interventions (Van Barneveld et al., 2012). This approach also reflects broader trends in higher education, where learning analytics is increasingly recognised as a transformative tool for enhancing teaching and learning. As the SHEILA report (Tsai et al. 2018) notes, learning analytics enables educators to respond to students' individual needs, closing feedback loops and promoting personalised learning experiences. By leveraging VLE data in this current study, it provided valuable insights into how students engage with digital learning tools, helping to refine educational strategies throughout the research process.

The monitoring of student activity on the VLE was part of routine module management and would have occurred as part of my normal teaching. However, students were clearly informed that their activity on the VLE would be monitored as part of the research and assured that the data would be used solely for research purposes. Transparency in how the data were collected, stored, and analysed was critical for maintaining trust and adhering to ethical standards (see Section 4.5 Ethical Considerations). This aligns with the Tsai et al. (2018) emphasis on privacy and responsible data usage as essential components of learning analytics.

Quiz Data

Quiz data were another important source of information, offering detailed insights into student performance, engagement, and the effectiveness of quizzes as formative assessments. The data collected from quizzes included not only student scores but also the number of attempts, the time taken to complete each quiz, and areas where students struggled. This detailed information was essential for understanding how students interacted with quizzes and how these interactions influenced their learning outcomes. Quizzes provided a direct measure of student learning, allowing the research to assess students' understanding of the course material. Analysing quiz results helped identify topics where students excelled or struggled, guiding the focus of subsequent educational interventions. For instance, if many students struggled with a particular question, it suggested a need for further instruction on that topic.

Quiz data also revealed patterns of student engagement. High quiz participation, frequent attempts, and time spent on quizzes indicated active engagement, while low participation might signal a need for additional support or motivation. These patterns were crucial for understanding the broader impact of quizzes on student learning and for making informed decisions about the design and implementation of future assessments.

Additionally, correlating quiz data with other factors, such as attendance and final exam results, allowed for a deeper analysis of student performance (see Appendix E: Quantitative and Qualitative Analysis). Understanding these relationships provided insights into whether regular quiz participation was associated with better academic outcomes, contributing to a comprehensive evaluation of the educational interventions used in the study.

Attendance Tracking

Although tracking the students' attendance was less important to the research, it still provided another way to monitor student participation and engagement throughout the course. Detailed records of lecture attendance were maintained, because those were routinely gathered as part of the HEI's policy anyway. These data gave a clear picture of student involvement in the module. This was done by me in a manual, paper-based way in class and then transferred to a spreadsheet for analysis at the end of the semester, as explained in the Analysis of Attendance Tracking section below.

The decision to track attendance stemmed from the well-established link between regular class attendance and academic success (Credé et al., 2010). By documenting attendance, the research aimed to verify whether this connection held true in the context of the study and to understand how attendance interacted with other factors, such as quiz engagement and online activity (see Appendix E: Quantitative and Qualitative Analysis). Analysing attendance data alongside quiz participation and survey responses helped to create a holistic understanding of the factors that contributed to student success.

Focus Groups

Focus groups were conducted at the end of ARC1 and ARC2 to gain deeper insights into student experiences, engagement with the quizzes, and their attitudes toward the intervention. Participants for the focus groups were selected using a sample of convenience method, where students voluntarily self-selected to participate based on their availability and willingness. The first focus group comprised seven participants, while the second included eight participants. A focus group was originally planned for ARC3, but after reviewing the rich qualitative data from ARC1 and ARC2 and noting that other data collection methods were yielding sufficient insights, I decided not to conduct an additional focus group in ARC3. This data collection method provided an invaluable opportunity to gather qualitative data that complemented the quantitative findings and informed the iterative cycles of action research. Focus groups are particularly effective in capturing deeper insights, as they allow participants to engage in interactive discussions that yield collective perspectives (Cohen et al., 2018). These group dynamics often elicit richer data than individual interviews, as participants build on each other's ideas, providing a broader range of reflections and opinions (Krueger, 1988). The decision to engage with focus groups aligns with their recognised value in

educational research, particularly in examining the interplay between teaching, learning, and assessment (Cohen et al., 2018). They are well-suited to studies exploring student engagement with formative assessment interventions, as their interactive nature facilitates the exploration of participants' attitudes, values, and experiences in a manner that might not be possible with surveys alone (Braun & Clarke, 2013). By focusing on themes such as quiz usability, engagement strategies, and the effectiveness of feedback, the focus groups provided actionable insights to refine the TEFAs before the next cycle.

Additionally, the use of focus groups ensured that students' voices were central to the research process, reflecting the participatory ethos of action research. This aligns with the principles of formative assessment, where student feedback informs ongoing improvements to teaching and learning practices. Bree and Gallagher (2016) highlight the value of using simple tools, such as Microsoft Excel, for qualitative analysis, enabling researchers to systematically code and categorise data while maintaining resource efficiency. This approach was integral to my analysis process, as I used Excel's colour-coding and sorting functions to organise focus group transcripts into themes and sub-themes, ensuring a rigorous yet accessible analytical framework.

Focus groups inherently present challenges, such as managing group dynamics and ensuring equitable participation (Morgan, 1997). To address these issues, careful attention was paid to group composition and facilitation. For instance, in ARC1, the independent facilitator ensured that quieter participants were encouraged to contribute, while in ARC2, I actively monitored the discussion to maintain focus and ensure all voices were heard. Strategies such as using open-ended questions and allowing sufficient time for discussion helped elicit comprehensive responses. This focus group was conducted by an independent facilitator to mitigate potential power dynamics and ensure participants felt comfortable sharing candid feedback. This group included a representative sample of students from the module, selected to capture diverse perspectives. The discussion was transcribed by an external service and anonymised to protect participant confidentiality. This focus group was particularly valuable in identifying broad themes related to quiz design and implementation, as well as uncovering areas for improvement in ARC2. At the end of ARC2, I facilitated the focus group myself. Ethical considerations, such as ensuring voluntary participation and maintaining confidentiality, were carefully managed, as detailed in 4.5. Ethical Considerations. The transcript from this session was analysed using Excel, where I

manually coded responses to identify recurring themes and sub-themes. This iterative process allowed me to examine specific areas of interest, such as students' strategic use of quizzes for exam preparation and their feedback on quiz length and format. For this longer focus group, I also organised responses into a table, categorising direct quotes under thematic headings. This structured approach helped me organise the data into actionable insights, which are specific findings that informed subsequent adjustments to teaching strategies and quiz design, while preserving the richness of individual student responses.

AoL Summative Exam Results

Final exam results from each semester were gathered as part of the data collection process in this research. They were later analysed to explore their relationship with student engagement and learning outcomes. While the primary focus of the study was on understanding student learning and engagement through quantitative and qualitative measures, such as surveys and focus groups, the inclusion of exam results provided an additional valuable quantitative metric. Although elements of the surveys, such as the Likert-type scale questions generated quantitative data, these results served more as an additional indicator of overall academic performance. The exam results were incorporated into the study to identify potential correlations between academic performance and participation in the interventions, particularly the use of quizzes. Additionally, correlations between exam results, attendance, and quiz attempts were explored to better understand the various factors that might contribute to student success (see Appendix E: Quantitative and Qualitative Analysis). These quantitative data were intended to complement the qualitative insights gathered from other data sources, offering a more rounded perspective on the effectiveness of the interventions.

The inclusion of exam results aimed to triangulate findings from the surveys and focus groups by determining whether the self-reported engagement and feedback from students were reflected in their overall academic achievements. However, as the survey data and first focus group data were collected anonymously, it was not possible to directly connect these qualitative insights to specific students' exam results. This limitation constrained the analysis but did not diminish the broader value of correlating aggregate-level trends.

Additionally, a comparison of the current exam results with those from previous years was planned to identify any significant deviations. This step was included as a safeguard

to detect any unusual patterns or changes in academic performance that might warrant further investigation.

Logbook/Observational Notes

Throughout the research, I maintained a logbook where I systematically recorded actions, events, and observations related to each iteration of the study. This approach was essential for capturing the dynamic nature of the educational interventions, providing a continuous record of what transpired during each cycle of action research. The logbook served as a detailed account of significant events, student interactions, and immediate observations as the research progressed. While less focused on deep reflection, this practice aligned with action research principles, which, as Cohen et al. (2018) describe, involve "a systematic learning process in which people act deliberately, though remaining open to surprises and responsive to opportunities" (p. 300). By maintaining a logbook, I was able to track these opportunities and challenges in real-time, allowing for adjustments to be made to the interventions.

My observational notes within this logbook focused on documenting student behaviours, engagement levels, and responses to the interventions. This systematic record-keeping provided an additional layer of insight, helping to contextualise the outcomes observed through other data sources such as surveys and interviews. The ability to observe and log student reactions in real-time was invaluable for understanding the immediate impact of the interventions and for planning subsequent actions.

Although less focused on introspective reflection, the logbook facilitated an iterative process of reflection and action, characteristic of action research. This cycle of noting, acting, observing, and adjusting, as emphasised by Lewin (1943) and further elaborated upon by Kemmis and McTaggart (1988), enables researchers to "plan, act, observe and reflect more carefully, more systematically, and more rigorously than one usually does in everyday life" (Cohen, Manion and Morrison, 2018, p.298).

This systematic documentation through the logbook was essential for recording what occurred during the research and provided a basis for understanding and interpreting the effectiveness of the interventions. As part of the action research framework, these observational notes contributed to bridging the gap between theory and practice, ensuring that the research remained grounded in the classroom's realities.

4.4. Analysis of Data

Data analysis was conducted systematically, including all of the sources mentioned in the previous section. Each data source provided unique insights, and together they offered a comprehensive view of student engagement and learning outcomes. The analysis was structured to ensure that data from different sources were integrated effectively, allowing for triangulation and the development of conclusions.

Sequence of Data Analysis

The order of data analysis followed the sequence of data collection and the iterative nature of the research cycles. Initially, VLE logs and quiz data were analysed early in the research process to gain insights into student engagement and performance. These findings informed the design of subsequent surveys and focus groups, which were then analysed to gather deeper qualitative insights. Attendance data were integrated throughout the analysis process, helping to contextualise both the quantitative and qualitative findings.

By structuring the data analysis in this manner, it was possible to continuously refine the educational interventions and address emerging challenges. Each round of analysis informed the next stage of data collection, ensuring that the research remained responsive to the emerging needs and experiences of the students.

Analysis of VLE Logs

The analysis of Moodle VLE logs focused on identifying patterns of student engagement within the digital learning environment. Key metrics included login frequency, time spent on assessments, and time dedicated to reviewing feedback. These data provided an objective measure of how students interacted with course materials and assessments, allowing for a detailed examination of their engagement.

The first step involved aggregating the raw logs into meaningful categories, such as average weekly login frequency, total time spent on assessments, and the distribution of activity across different course elements. This aggregation required cleaning and organising the raw data. For instance, in ARC1, the exported dataset from Moodle initially contained 9 columns and 9,370 rows. After processing, such as removing references to myself as the lecturer, assigning week numbers to dates, and grouping the data by relevant categories, the dataset was reduced to 6,264 rows. This step ensured that the data were manageable and aligned with the study's objectives. Once cleaned, the data were analysed to identify trends and relationships. For example, pivot tables

were created to extract specific insights, such as weekly Moodle usage, quiz attempts, and total student activity (see Appendix E: Quantitative and Qualitative Analysis).

The insights gained from this analysis were important in refining the interventions. For example, understanding how students interacted with feedback allowed for adjustments to the way in which feedback was presented in subsequent cycles. Similarly, identifying weeks with lower activity levels highlighted potential points of disengagement, informing strategies to increase participation. The process also revealed variations in how different student groups utilised the VLE, which shaped the design of targeted interventions. In ARC1, the process of visualising the data through pivot tables and charts played a critical role in making the findings accessible and actionable. For example, Figure 10 illustrates how the weekly distribution of Moodle activity and quiz attempts was mapped to provide a clear picture of student engagement trends over the semester. This step not only supported data-driven decisions within the action research cycles but also ensured transparency and clarity in communicating the findings.

Analysis of Quiz Data

The analysis of quiz data was conducted in several stages using SPSS and Excel. Firstly, descriptive statistics were used to summarise student performance across the quizzes. This initial stage provided an overview of achievement levels, including average scores and the distribution of grades. Engagement with quizzes was then examined, focusing on the number of attempts made by students and the extent of their participation across all quizzes.

To further refine the quizzes, item analysis was conducted in Excel to identify the most and least challenging questions for students (see Appendix E: Quantitative and Qualitative Analysis). This analysis helped me determine whether specific questions were too difficult or too easy, providing valuable insights for improving quiz content and instructional focus in subsequent research cycles.

The analysis then moved to inferential statistics on SPSS to explore the relationships between quiz data, attendance, and module grades. Spearman's rho was used to look at the correlations between these variables. For ARC3, numbers were too small to amalgamate quiz attempts, so here t-tests were used to compare attendance, theory, and overall module grades for students who had taken individual quizzes and students who had not.

Analysis of Attendance Tracking

Attendance data were first analysed using simple descriptive statistics to establish overall attendance rates and identify patterns of absenteeism (see Appendix E: Quantitative and Qualitative Analysis). This process began with logging attendance for each student across every class during the semester, which was recorded manually and later transferred to a spreadsheet. Weekly attendance data were totalled at the end of the semester, and a percentage attendance rate was calculated for each student, providing a clear picture of individual and overall student participation in physical classes and workshops. These data were then correlated with quiz performance and final exam results to explore the relationship between regular class attendance and academic success. By examining these correlations, the analysis aimed to determine whether students who attended classes more frequently performed better in quizzes and exams. Additionally, this analysis considered whether patterns of absenteeism were linked to lower engagement levels on the VLE or reduced quiz participation.

In addition to these quantitative analyses, attendance data were also integrated with qualitative data from surveys and focus groups. This combined approach allowed for a deeper exploration of the reasons behind attendance patterns, such as personal challenges or perceptions of the course's relevance, adding context and nuance to the quantitative findings.

Analysis of Surveys

The analysis of survey data employed both quantitative and qualitative methods, mirroring some of the techniques described in the Analysis of Focus Groups section to ensure methodological consistency. Closed-ended survey questions, particularly those using 5-point and 7-point Likert-type scales, were analysed quantitatively using Excel (see Appendix E: Quantitative and Qualitative Analysis). Descriptive statistics, such as averages and frequency distributions, were calculated to identify trends in student satisfaction, perceived learning benefits, and engagement levels with the quizzes. This provided a broad overview of the numerical data, enabling comparisons between research cycles and informing adjustments to the intervention.

Open-ended survey responses underwent thematic analysis (TA) following the same six-phase framework outlined by Braun and Clarke (2006) that was used in the focus group analysis. Although the volume of responses was smaller, the TA process was adapted to ensure the insights were meaningful and actionable. Similar to the focus

group analysis, initial familiarisation involved compiling all responses into a Word document for review. Colour-coding was then used to highlight recurring ideas, which were grouped into preliminary categories. These categories were subsequently refined into broader themes. To deepen the analysis, the survey responses were split into two subgroups: those from students who engaged with the quizzes and those who did not. This segmentation enabled a comparison of perspectives, providing insight into how different levels of engagement influenced student experiences and feedback. For instance, themes from non-engaged students often revealed barriers to participation, such as time constraints or perceived irrelevance, whereas engaged students highlighted benefits like improved understanding and efficient revision.

Drawing parallels to the focus group analysis, the open-ended survey responses were similarly categorised and analysed for their frequency and significance. While focus groups provided richer discussions and opportunities for group dynamics to shape insights, the survey responses allowed for individual reflections, which complemented and sometimes contrasted with the collective perspectives gathered during focus groups. This dual approach strengthened the overall understanding of student engagement with the quizzes.

Analysis of Focus Groups

As discussed in the Focus Groups section above, the focus group data were analysed using TA, guided by the six-phase framework outlined by Braun and Clarke (2006). While this approach was not applied with the depth required for large-scale qualitative studies, it provided a structured method for me to extract meaningful insights from the discussions. This aligned well with the exploratory and iterative nature of this research. The emphasis on flexibility in TA, as described by Maguire and Delahunt (2017), was particularly relevant for adapting the method to this smaller dataset.

The first phase, familiarisation, involved repeated engagement with the focus group transcripts, which were either externally transcribed and anonymised (ARC1) or self-transcribed (ARC2). This stage allowed for an initial identification of salient points and recurring patterns in the data. During the coding phase, I systematically highlighted segments of text that corresponded to key ideas related to quiz engagement, such as device preference, feedback utility, and quiz length (see Appendix E: Quantitative and Qualitative Analysis). Colour-coding was used to distinguish different themes, enabling a visual representation of overlapping and divergent perspectives. Theme development

involved grouping related codes into broader categories, such as “strategic quiz usage,” “impact of quiz length,” and “preferences for immediate feedback.” For ARC2, a more structured approach was employed by organising quotes into a table format, categorising responses under thematic headings while retaining speaker identifiers (see examples in Appendix E: Quantitative and Qualitative Analysis, specifically, E2: Focus Group Analysis (ARC2)). This allowed for a clearer synthesis of individual and collective insights. During the reviewing and refining of themes, the preliminary groupings were re-evaluated to ensure alignment with the research objectives and to integrate nuances in student perspectives. Themes were redefined to reflect their contribution to understanding quiz engagement, leading to actionable insights for refining the intervention. For instance, feedback on quiz design was split into subcategories addressing question type, length, and feedback clarity, providing a more granular understanding of student needs. Finally, the writing-up phase synthesised these themes into a coherent narrative, linking the findings to broader educational practices and informing the iterative cycles of the research. Extracts from the focus group discussions were used to illustrate key points, providing important examples of student perspectives while maintaining their anonymity.

During the analysis of all data gathered in each research cycle, the qualitative data were also compared against the quantitative survey results, to identify congruences or discrepancies between what students reported in their responses and their actual behaviours as captured by the VLE logs and quiz data. As mentioned in Section 4.3.5. Data Gathering Instruments, this triangulation process ensured that the findings were well-rounded and grounded in multiple sources of evidence.

4.5. Ethical Considerations

In this research, ethical issues extended beyond the usual considerations of confidentiality, anonymity, and data safeguarding, as I was researching within my own teaching environment and involving my own students. This setting was inherently complex, requiring careful management of ethical considerations to ensure the integrity and rigour of the research.

A primary concern was power bias, which arises when the inherent power dynamics between the researcher and participants affect the research process and outcomes. In educational action research, particularly when the researcher holds an authoritative role such as a lecturer, there is a risk that participants may feel obligated to respond in

specific ways or feel pressured to participate in the study, potentially skewing the results. Brydon-Miller and Maguire (2009) emphasised that traditional research can reinforce these power imbalances, making participants feel they must conform to the researcher's expectations, especially when a clear power differential exists.

Given my dual role as both the researcher and the students' lecturer, this issue was especially pertinent. Students might have felt a sense of obligation to participate or provide feedback they believed I wanted to hear. Brookfield (2017) drew attention to the importance for educators to be conscious of how their authority can influence student responses and to actively take steps to minimise this influence. Recognising this, I sought to implement strategies to mitigate power bias, ensuring that students felt free to provide honest and uninfluenced feedback.

Wood and Zuber-Skerrit (2013) suggested that involving participants as co-researchers can help break down these traditional power structures, making the research process fairer and less influenced by power bias. In this study, students played an essential role in co-creating the TEFAs. By providing detailed feedback through surveys and focus groups, they influenced the iterative development of the quizzes, shaping their design and implementation. Their feedback was integral to improving the TEFAs, ensuring they were not only more effective but also more relevant to students' needs and preferences. This collaboration benefited the students directly, as their input contributed to more engaging and effective assessments, and it also helped refine the intervention for future cohorts.

This approach fitted well with the principles of participatory action research, which is focused on empowering participants, fostering collaboration and creating a more balanced research environment. Comprehensive safeguards were also put in place to minimise power bias and protect all parties involved. From the outset, it was important to establish a clear distinction between the educational experience of the student and the evaluation of the intervention's effectiveness. This research focused solely on the latter. Students who chose not to participate in the research, by not completing surveys or taking part in focus groups, were assured that their educational experience would remain unaffected by their decision.

Acknowledging the importance of these ethical considerations in maintaining the integrity of the research, the process for securing ethical approval was carried out with careful attention to detail and is outlined below.

Ethical Approval Process

Ethical approval was first sought and granted from my institution, Higher Education Institute-A (HEI-A), in my capacity as a lecturer-researcher, and subsequently from Maynooth University, where I was a PhD student-researcher. At HEI-A, this process involved completing a series of forms (see Appendix A: Ethics Documentation), including:

- Ethical Approval Checklist for Research Projects
- Detailed Relevant Ethical Issues Form
- Participant Information Leaflet
- Participant Consent Form

These forms were submitted to the Research Ethics Committee of the School where I am based. The process included a review and an oral face-to-face interview. Based on the committee's recommendations and feedback, the application was amended where necessary. Upon securing approval from HEI-A, an application was then submitted to the Social Research Ethics Sub-Committee (SRESC) at Maynooth University. This application included the following documents, which are included in Appendix A: Ethics Documentation:

- Student Participant Information Letter
- Student Consent Form
- Focus Group Consent Form

Both the HEI-A and Maynooth University ethical approvals were fully secured in time for the implementation of the first action research cycle (ARC1).

In preparation for the ethical approval process, I engaged with my supervisor and with relevant literature on research ethics (McTaggart, 1997a; Zeni, 1998; Cain, 2011; Ingleby, 2012; Cohen et al., 2018a). I also attended research ethics workshops and seminars at both HEI-A and Maynooth University. Additionally, I had a series of meetings with the Head of Teaching and Learning at HEI-A. These efforts ensured that my research methods were well-informed and rigorous, and that I had established processes to address any potential ethical issues throughout the research process.

Preliminary Ethical Observations and Actions

Some basic observations and procedures were established to ensure ethical compliance throughout the research. The planned participants were in their second and third years,

ensuring that all were over 18 years of age and thus not considered minors. Similarly, there were no students classified as 'vulnerable persons' in any of the student groups. Before each research cycle, the target population was re-checked using class logs kept in HEI-A's School administration office to confirm this.

The student groups for the three action research cycles were carefully selected, with details provided in Section 4.3.2 Research Participants. I served as the lecturer for this module across all groups for the duration of the research, allowing me to implement and observe the interventions directly.

At the outset of the research, ethical approval was sought and granted for the possibility of allocating a nominal grade for engaging in the formative assessments. This was considered as a potential small incentive to encourage students to use the technology. It was anticipated that this allocation of marks would neither compel nor deter students from engaging with the platform, thus maintaining the voluntary nature of participation. However, as the research progressed, I decided not to allocate any marks during the research cycles. This decision was made to ensure that student participation remained entirely voluntary and to avoid any potential bias in the students' engagement with the formative assessments.

Power Relationship and Power Bias

As described above, I was lecturing these students, assessing them, and also researching them. Consequently, there were power relationship issues. It was vital to the success of this research that these were mitigated as much as possible, that ultimately the students did not feel any pressure to participate in the research, and also that their level of participation would not have any influence on their final exam grade. Every attempt was made to deal with these power/ethical issues before, during and after the research took place. The research cycles were designed and undertaken with ethical considerations in mind, thus ensuring the integrity and quality of all research methods. Procedures were put in place to demonstrate the rigour in the research process, instil trust in the students and ensure trustworthy exam results. Each of the data collection methods was explained and what exactly would be recorded, stored, analysed for each one. The section below gives a synopsis of each method.

Surveys

Participation in the surveys was anonymous. Students were sent a link to the survey, or in some instances a hardcopy was distributed in class. In either case, students could

choose to complete it or not. There was no connection between the participant response and the participant, so I had no way of knowing who had or had not participated and the students were made aware of this.

Quizzes

Initially, the student name and student number would be identifiable from the quiz data, and this was necessary for the student learning experience. This is part of normal teaching and learning practice for any groups where technology is being used. However, for this research, after the analysis phase, all identifiers were removed from the quiz data. The reason for this was twofold: firstly, these identifiers are not necessary for the research, and secondly, removing the identifiers would protect the privacy of the participants in any published material. This was explained to all participants at the start of the process.

VLE Logs

It was explained that the purpose of the online monitoring of Moodle or any other third-party logs, was not for attendance or grading, but solely for the purpose of this research. Ethical approval was explicitly sought and granted for accessing and analysing VLE usage data as part of the research process. Again, after the analysis phase, all identifiers were removed from the Moodle data.

Focus Groups

To mitigate power dynamics and potential bias in the participant selection and conduct of Focus Group 1, the session was conducted independently of me as the researcher. A lecturer from HEI-A, who had no prior contact with the participants, was responsible for identifying the target population and randomly selecting participants. This lecturer then conducted Focus Group 1 and managed data collection and transcription. To ensure anonymity, participants were assigned unique identifiers, which were used in the transcripts and field notes instead of their actual names.

Students were informed that their identities would be protected. The first focus group was audio-recorded, lasting approximately 40-45 minutes, with transcription and anonymisation handled by a third party before the data was passed on to me. Focus Group 2 took place at the end of Semester 2, after the second research cycle. I conducted this session, with an independent observer in attendance to oversee participant selection and ensure impartiality.

The timing of Focus Group 2 was deliberately chosen after all assessments were completed and grades issued. This was to ensure that students could provide honest and candid feedback without any concern that their participation might affect their academic results. By conducting the session after the grades were released, I aimed to reduce any potential influence on students' willingness to share openly, as the fear of repercussions was mitigated. This approach reflects an ethical commitment to minimising power bias, especially given my role as both researcher and assessor.

Participants were given the option to withdraw from the study. They were assured that their contributions would remain non-attributable, with each participant assigned a number as their identifier during the discussion. If a participant wished to review or remove their input, this was accommodated. The large pool of potential participants ensured that replacements were available if necessary.

Students were briefed on the research focus at the start of each cycle, but they were not asked to participate until after their module assessments were completed and they had received provisional grades. This approach was intended to ensure that students did not feel pressured to participate, especially since I was responsible for grading their final exams. By conducting Focus Group 1 with an independent facilitator and scheduling the second after grades were issued, the power differential was effectively reduced.

Both focus groups provided valuable insights that enriched the qualitative data of the study. Focus Group 1 was particularly critical, with Colleague A from a different department facilitating the discussion, ensuring an organised and open environment where participants could freely express their thoughts. Colleague B, from my teaching department, managed the technical aspects, including recording and ensuring participant anonymity in the transcripts, and upholding the ethical standards of the research. Focus Group 2, conducted by myself, also contributed significant findings that informed the later stages of the research. The perspectives gathered in these sessions offered a deeper understanding of the learning experiences and contributed to the iterative nature of the action research process.

Upon thematic analysis of the transcript derived from the focus group, I gleaned a range of insights that shed light on the students' interactions with, and attitudes towards quizzes. These insights were instrumental in providing a deeper understanding of student experiences, their individual preferences, and their constructive recommendations for improving the quiz format. This analysis not only enriched my

understanding of how students engage with educational tools but also offered critical feedback to significantly inform future research cycles.

The focus group, conducted at the end of the first research cycle, was strategically timed to capture students' reflective feedback after they had completed a substantial portion of the module. This approach allowed for the collection of fresh insights on their learning experiences and quiz engagement, which I could leverage to improve the educational strategies and tools in the following cycles. For example, feedback on quiz length and question complexity directly informed subsequent adjustments to better align with students' learning styles and time constraints.

Having collected and briefly analysed other data from this cycle at this stage, the focus group was more important in being able to drill down further into areas I knew were issues, as well as areas for which I lacked data. In essence, this focus group acted as an important cornerstone for the iterative improvement in my research.

Final Exam Results

Quiz usage and final exam marks were analysed at an aggregated level. As the surveys were anonymous, there was no link between the data collected in surveys and the student. Ethical approval was sought and granted specifically for using student exam results in this research, ensuring compliance with institutional ethical guidelines. Again, this is consistent with the clear distinction between the educational experience of the student and the evaluation of the effectiveness of this intervention. However, it was still important to make sure the exam results were not open to lecturer influence or bias. To ensure the standard of grading was consistent across scripts and across years, the following procedures were implemented:

- Marking Scheme with Rubric: As well as a comprehensive marking scheme, a rubric/matrix detailing further information about grade levels was created.
- Verification process of External Examiner: The research was explained to the External Examiner for these modules linked to this study and he was asked to correct a larger sample of scripts than normally required. A total of 33% of the scripts were sent to the External Examiner, rather than the normal 20%.

Attendance Data

Ethical approval was explicitly obtained for the use of attendance data as part of the research, ensuring all institutional guidelines around privacy and student data protection were followed. Attendance data were collected strictly for analytical purposes within

this study, not as part of formal assessment procedures, and any identifiable information was anonymised after initial analysis.

Participant Approval and Confidentiality

Research participants were fully informed about the purpose, methods and intended possible uses of the research, what their part in the research entailed and what risks, if any, could arise. They were informed that their participation was entirely voluntary, free from any coercion, duress or any other offer of inappropriate incentives. All participants were assured of the confidentiality of the material shared and that they would not be identifiable within the research. The confidentiality of information supplied by research subjects and the anonymity of respondents was respected, ensured and secured. Finally, all queries were addressed with the students prior to the beginning of the research.

Safeguarding Data

The student surveys were administered using an online survey platform which complies with Data Protection legislation in the EU/EEA via the US Government Safe Harbor programme. To ensure confidentiality, the original data were removed from the online survey platform after collection. The raw data were downloaded in Excel, SPSS, or a similar format, and students' names were converted to codes (e.g., Student 1, 2, 3). No table was retained to reconnect the codes to the original names, ensuring anonymity.

Data collected through Moodle or other third-party platforms were similarly downloaded, with the original data subsequently removed from these websites. All data were securely stored for the duration of the research project.

For ARC2, a third-party tool was used to administer the quizzes. After each quiz, the data were promptly downloaded and securely stored locally, with the remote server data being securely deleted. This organisation, like the online survey platform, fully complied with current Data Protection legislation.

Although all focus group data were anonymised and students assigned numbers, anonymity between the students who took part in the focus group was not possible, nor was it necessarily essential, as these students were peers whose individual and collective interpretations of their learning experiences formed the data to be gathered. What was essential was minimising the potential bias inherent in the asymmetrical power relationship between lecturer and student. For the first focus group, I addressed this by not taking part in the session. Additionally, both focus groups were independently transcribed, with all contributions anonymised and kept non-attributable in any research

outputs. At the start of the focus group sessions, I informed participants of the limits to confidentiality, including the understanding that absolute confidentiality could not be guaranteed due to their familiarity with one another. They were asked to respect the confidentiality of their peers and refrain from discussing individual contributions outside the group. These procedures, along with the limits to confidentiality, were outlined in Section 3.3 of the ethics policy of Maynooth University (see Appendix A: Ethics Documentation).

4.6. Conclusion

In this chapter, I outlined the methodological framework guiding this research, detailing the rationale behind selecting an action research approach, and I also described the methods employed to collect and analyse data. This approach allowed for an iterative and reflective exploration of my educational practice, with a focus on enhancing student engagement and learning outcomes through technology-enhanced formative assessment. The insights gained from this process inform the subsequent chapter, where I present the findings from the action research cycles, offering a detailed analysis of how the interventions impacted student learning and engagement.

Chapter 5: Findings

This chapter reports the results from the three action research cycles. Each cycle focused on the development, implementation, and subsequent improvement of a series of technology-enhanced formative assessments (TEFAs) within a virtual learning environment (VLE). Data collection for this iterative process drew on a variety of sources, including information directly related to the TEFAs themselves, the broader VLE platform usage, student perspectives and my own observations and reflections. Specifically, the research analysed data from the attendance records, exam results, focus group discussions, online quizzes, researcher journal observations, student surveys and VLE logs.

In this chapter, key observations made throughout the research are explored, highlighting how these insights informed the development and improvement of subsequent cycles. This iterative approach ensured the continuous refinement of the intervention (TEFAs) throughout the research process. Moreover, within each cycle, iterative, continuous enhancements occurred based on the data collected during that cycle. The results of the analysis are presented below by describing the findings from the three action research cycles and the overarching findings.

5.1. Action Research Cycle 1 (ARC1)

As explained in Chapter 4, Research Methodology, the first action research cycle involved the collection of data from a variety of sources to inform the research process. For this cycle, these included a pre-intervention survey, a mid-semester survey, an end-of-semester survey, VLE logs, quiz data, attendance logs, exam results, an end-of-semester focus group and journal observations. A detailed explanation and analysis of these data are presented below.

Pre-Intervention Survey

In the second week of the semester, I issued a survey to the students involved in this study. I wanted to gauge their access to technology, engagement levels with Moodle, prior use of quizzes, and their current and past academic motivation levels. The aim was to establish a baseline understanding of where this large cohort of students stood in these key areas. This would help inform the design and implementation of the TEFAs for the module in the first research cycle. A total of 94 students responded out of the 116 who were invited to participate in the survey, and the findings provided me with

valuable insights into the students' digital readiness and initial attitudes toward the module.

The survey results indicated that the majority of students had reliable access to digital devices. A significant 94% of respondents reported owning smartphones, 90% had laptops, 59% had access to desktop PCs, and 50% reported using tablets. This widespread availability of devices suggested that students were well-equipped to engage with the online components of the course outside my classroom.

Moodle engagement was similarly high, with 99% of participants stating that they accessed Moodle at least once a week. Notably, 70% of students accessed it more than four times per week, primarily from home, the college library, or computer labs on campus. The devices most frequently used to access Moodle were laptops, PCs in the library, and smartphones, indicating a strong reliance on personal and institutional computing resources. When asked about their prior experience with Moodle quizzes, 40% of students revealed they had never used them before, and almost 85% had encountered them in only two or fewer modules. Despite this limited experience, 80% of participants stated that they would use practice quizzes in this module for revision purposes, even if no marks were awarded. An additional 18% expressed a tentative interest, indicating a general openness to engaging with the quizzes.

In terms of their initial perceptions of the module, 62% of participants agreed or strongly agreed that it was well-structured, and 67% felt that the content was relevant to their programme of study. However, students were more uncertain when asked about the module's difficulty level and its potential to be intellectually stimulating. While they believed the learning materials on Moodle would assist them, they were unsure of the intellectual demands the module might pose.

Mid-Semester Survey

After the first two quizzes were released, I made some journal observations on the levels of engagement, the usability of the quizzes and how beneficial they were from an educational point of view. Informal comments from students helped with these observations, and I also sought formal, tangible, anonymous feedback from the students to inform any changes for the next quiz. This type of feedback was expected to be more objective and would allow students to be more honest. With this in mind, I administered a Mid-semester Intervention Survey (see Appendix D: Surveys) at the start of Week 9 of term. The data collected from the 56 respondents (48% response rate) from this

paper-based survey provided insights on their experiences of the first two quizzes. This helped inform the planned changes I intended to make to the next two quizzes in this research cycle.

The analysis showed that a significant majority, 70% (39 respondents), had not completed any quizzes up to the point of the survey. On the other hand, just over 30% (17 respondents) of the participants had engaged with the quizzes, with 18% (10 respondents) completing one quiz and 12.5% (7 respondents) completing two quizzes. Among those who had not attempted any quizzes, a substantial 87% expressed intentions to attempt a quiz before the January exam, with an additional 10% considering the possibility, leaving only a single student who had decided against attempting any quizzes. Meanwhile, of the 17 respondents who had attempted quizzes, the vast majority, 82% (14 respondents), reported having completed a quiz once or twice, whereas a smaller fraction, 18% (3 respondents), had completed a quiz three to five times.

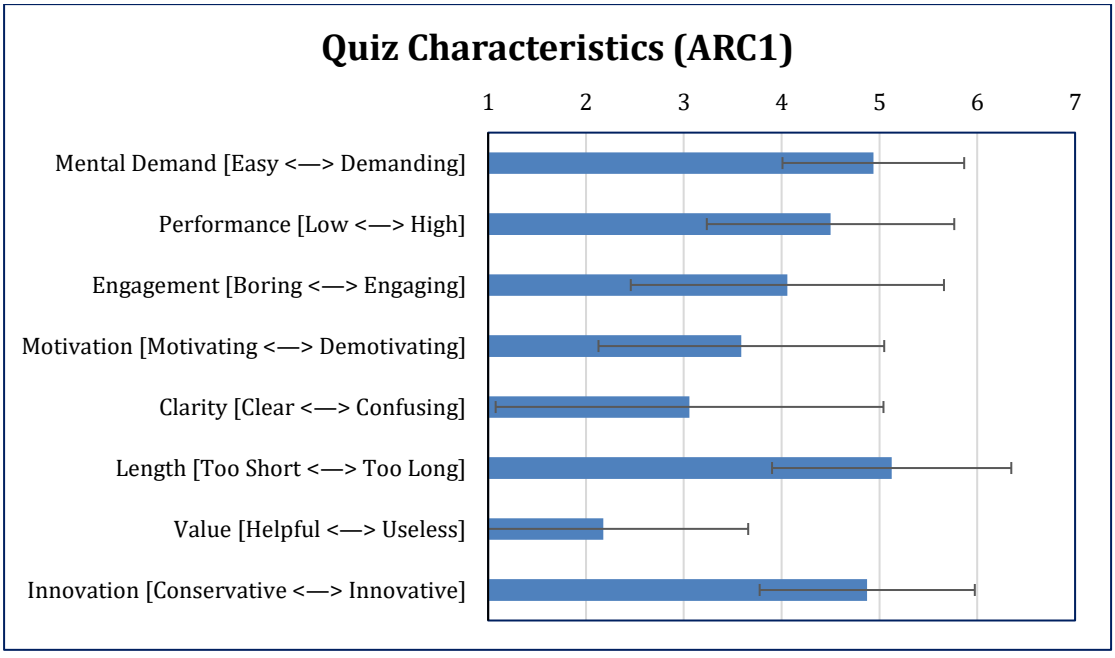


Figure 9. Quiz Characteristics [ARC1 Mid-Semester Survey]
Note: Scores indicate averages on a 7-point Likert-type scale. Error bars indicate ±1 SD

The set of questions to assess the usability and educational efficacy of quizzes, was based on a 7-point Likert-type scale, and yielded the following findings (Figure 9). The inclusion of standard deviations is important as they provide insight into the variability of student perceptions.

The quizzes were perceived as quite demanding, with an average mental demand rating of 4.94 (SD = 0.93), indicating that the tasks were challenging. The findings showed that 63% of respondents found the first two quizzes mentally demanding, with no participants considering them easy. Despite the challenges, the level of performance was moderately high, with an average rating of 4.5 (SD = 1.26), and 63% of respondents felt they had successfully completed the quizzes, though 25% reported low success rates.

Engagement levels with the quizzes were slightly above average, with an engagement rating of 4.06 (SD = 1.6). However, the wide standard deviation suggested that students were quite divided on this aspect, as 47% found the quizzes engaging, while 41% leaned towards finding them boring. Similarly, the motivation aspect received an average rating of 3.59 (SD = 1.46), again reflecting a mixed response: 41% found the quizzes motivating, 24% demotivating, and 35% were neutral.

The clarity of the quizzes was rated at 3.06 on average (SD = 1.98), with 65% of students finding them clear, though the large SD indicates substantial variation in responses with 29% reporting confusion. This variability is important, as it highlighted the need for a clearer quiz design to address the students who struggled with understanding. The length of the quizzes was deemed too long by 56% of respondents, as reflected in an average rating of 5.13 (SD = 1.22), with no students finding them short and 44% expressing neutrality. The relatively smaller SD suggested there was more agreement on this aspect

On a positive note, the helpfulness of the quizzes was highly regarded, with an average rating of 2.18 (SD = 1.48), with 76% of students found the quizzes beneficial, whereas only 6% considered them ‘useless’. The SD here is smaller, showing a clearer consensus that the quizzes were useful.

Finally, in terms of innovation, the quizzes received an average rating of 4.88 (SD = 1.1), indicating a slight inclination towards innovation. 50% of students perceived the quizzes as more innovative, with only 6% viewing them as conservative and 44% remaining neutral. The narrower SD here implies a more consistent view among students on this aspect.

These findings suggest that while the quizzes were challenging and lengthy, they were largely seen as engaging, clear, and beneficial from an educational standpoint with a moderate degree of innovation.

Responses to the Open-Ended Survey Questions

Seven open-ended responses were collected, with six students having completed at least one quiz and one student who had not yet attempted any. The question posed was simple: "Any comments?" Given the small number of responses, it is difficult to generalise the findings, as the answers varied significantly. Among those who did not participate, individual comments shed light on their reasons for non-engagement. One student conveyed the pressures of their schedule: *"I really want to, but all of the time constraints, volume of work and assignments to do takes more of my time."* This comment is indicative of the complex juggling act students face with competing academic demands. Another student mentioned their unease with technology: *"Besides, I am a bit new to IT."* This type of response revealed the potential impact of digital literacy on educational engagement. On the other hand, the remarks from students who completed the quizzes highlighted their educational value. One student appreciated the quizzes as a chance to revise content, saying *"The quiz was actually a very good revision exercise."* Another student recognised the quizzes' role in deepening their understanding of the coursework: *"It gives a great insight into what has been taught in class."* A third student commented on the quizzes' informative nature: *"It was good and contained many [sic] information. I came across some terms that I haven't seen in our presentations in the class."* One student offered a different perspective, distinguishing the quality of the quizzes from the appeal of the subject matter: *"It is not that the quizzes weren't good, the module and subject itself is very boring, leaving it hard to learn or want to learn"* highlighting the importance of student interest in the content and suggesting that, while the quizzes are useful, the subject's lack of appeal made it difficult for this student to engage fully with the material.

At this mid-way stage of the first research cycle, the comments, though few in number, offered varied insights into individual commitment, motivation, and ability and reflected personal experiences rather than broader trends across the cohort. When combined with the quantitative data collected in this survey, such as the perceptions of quiz difficulty, engagement levels, and usefulness, it became clear that some adjustments were needed. The feedback, particularly on quiz length, mental demand, and time constraints, informed the modifications I made in the remainder of this cycle and subsequent cycles. These included refining quiz design to make the quizzes more manageable and exploring ways to better support student motivation and engagement.

End of Semester Data

As the first research cycle concluded, a comprehensive analysis of the data collected throughout the semester was conducted. Although some data were reviewed in real-time, this end-of-semester period provided valuable time to evaluate overall trends and engagement levels. The data presented here cover all four quizzes conducted during the cycle, offering insights into student participation and interaction with the online quizzes. At the start of the semester, 134 students were enrolled in the module. However, after reviewing their engagement in assessments, including the final exam and continuous assessments, it was determined that 18 students had either withdrawn or did not participate in any assessments. Excluding these students left 116 active participants for analysis.

Moodle Engagement Logs and Quiz Data

From the Moodle Virtual Learning Environment (VLE) statistics, it was clear that there was a high level of engagement with the quizzes. Over the semester, 85 students (73%) attempted at least one quiz, while 44 students (38%) attempted more than one. However, Figure 10 illustrates that the majority of quizzes were taken in the days leading up to the final exam. The following section includes a detailed account of Moodle engagement data and quiz attempts for the first cycle, providing this level of detail in this first cycle only to familiarise the reader with the nature of the data collected and the significance for future cycles.

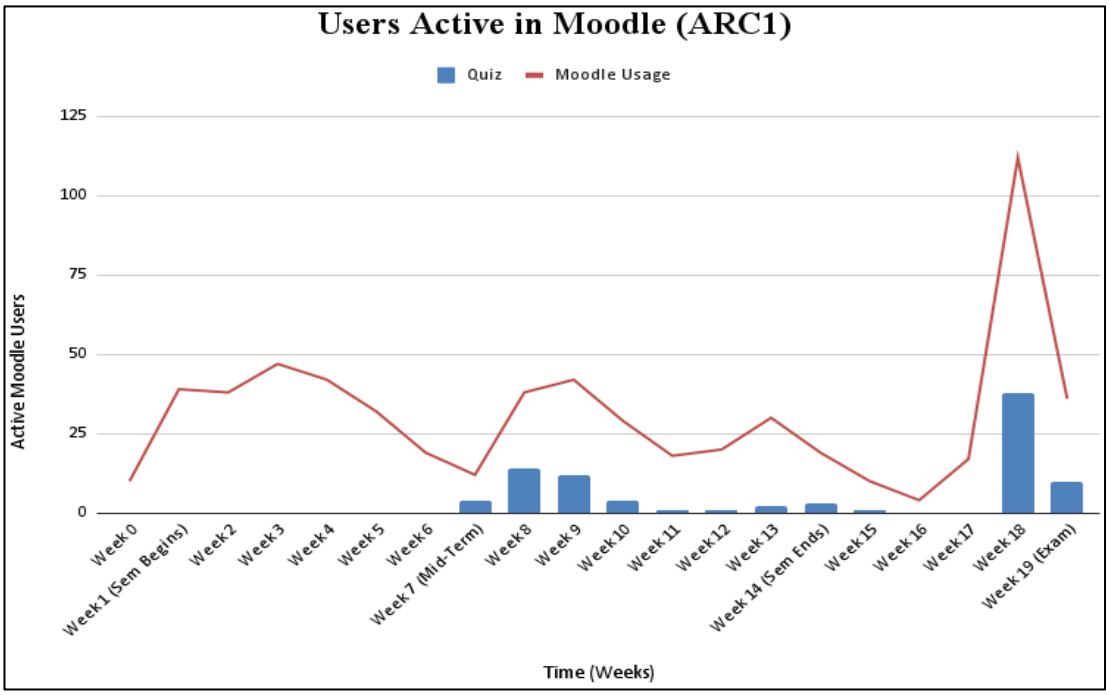


Figure 10. Weekly VLE Engagement Analytics [ARC1]

Figure 10 is a combined line and bar graph illustrating the weekly number of active Moodle users and completed quiz submissions leading up to the final exam in Week 19. Data points represent each week of the semester, from Week 0 (before classes commenced) through to the exam week. The line graph tracks overall Moodle usage, while the bars reflect the number of students who completed quizzes each week. Initially, Moodle usage starts low, with a rise to a peak of 47 users in Week 4, followed by a decline until Week 7, when Quiz 1 was introduced. This release correlates with a noticeable increase in both Moodle activity and quiz completions, with 38 users active. After this peak, activity fluctuates, generally declining towards the end of the semester, reaching a low of 4 users in Week 14, coinciding with the Christmas break.

In the lead-up to the final exam, Figure 10 shows a sharp increase in Moodle activity, peaking at 112 users and 38 quiz completions in Week 18, suggesting intensive exam preparation. On the exam day in Week 19, a considerable level of activity is observed even in the early hours, with 36 users and 10 quiz completions recorded from midnight to 9 am. This pattern shows the link between the quiz release in Week 7 and increased Moodle usage, as well as the substantial spike in both Moodle usage and quiz completions during the week before the final exam, indicating that many students engaged with the platform for last-minute study and review.

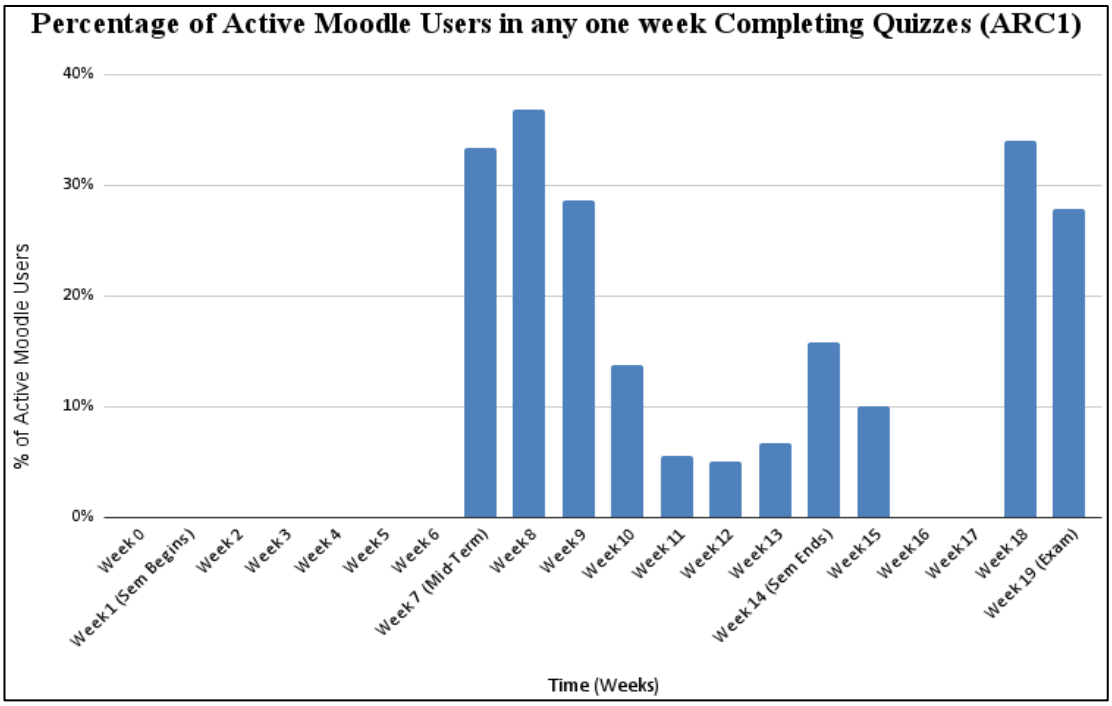


Figure 11. Percentage of Active Moodle Users Completing Quizzes [ARC1]

Figure 11 shows the percentage of active Moodle users in Module A who completed quizzes each week from Week 0 (just before the start of the semester) through to the final exam in Week 19. Quiz activity begins in Week 8 with the launch of the first quiz, reaching a peak of over 37% of active users completing quizzes. After this initial surge, the proportion of students completing quizzes is seen to decline, with some fluctuations, reaching its lowest point during the Christmas break in Weeks 16 and 17.

A notable increase is evident in Week 18, when quiz activity spikes again, with over 30% of active users completing quizzes, just before the final exam. In Week 19, significant quiz activity is recorded, but it represents only 9 hours of data, from midnight to 9 am on the day of the final exam, indicating last-minute preparation. The graph highlights key engagement periods, such as the initial quiz launch and the intensified activity in the final weeks, suggesting that students primarily use quizzes for exam preparation rather than as continuous learning tools throughout the semester.

Quiz Engagement but Not Full Completions

In the initial analysis, Figures 10 and 11 focus exclusively on users who completed quizzes, capturing a direct measure of completion and immediate learning outcomes. Figure 12 expands this analysis to include users who clicked into quizzes but may not have completed them, providing insight into partial engagement.

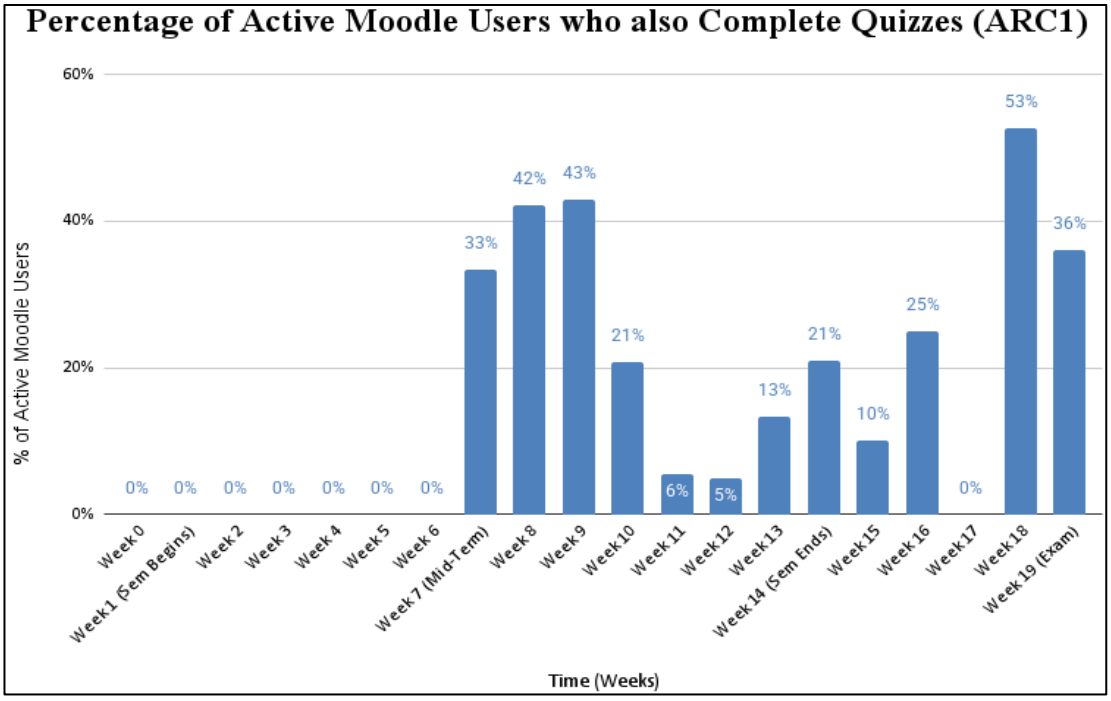


Figure 12. Percentage of Active Moodle Users Engaging with Quizzes [ARC1]

Figure 12 reveals that a notable portion of active Moodle users accessed quizzes each week without necessarily completing them. This interaction pattern suggests that many students found value in the quizzes for some reason. The high rate of partial engagements indicates that students may have used quizzes to review material or gauge their understanding, even without actually completing and submitting the quiz. This behaviour highlights the role of quizzes as a flexible study resource, allowing students to engage on their own terms. This additional layer of data suggests that the impact of quizzes is diverse, extending beyond completion-based feedback. The high level of engagement without completion could also reflect practical challenges mentioned in the survey responses, such as time constraints or difficulties engaging with the material.

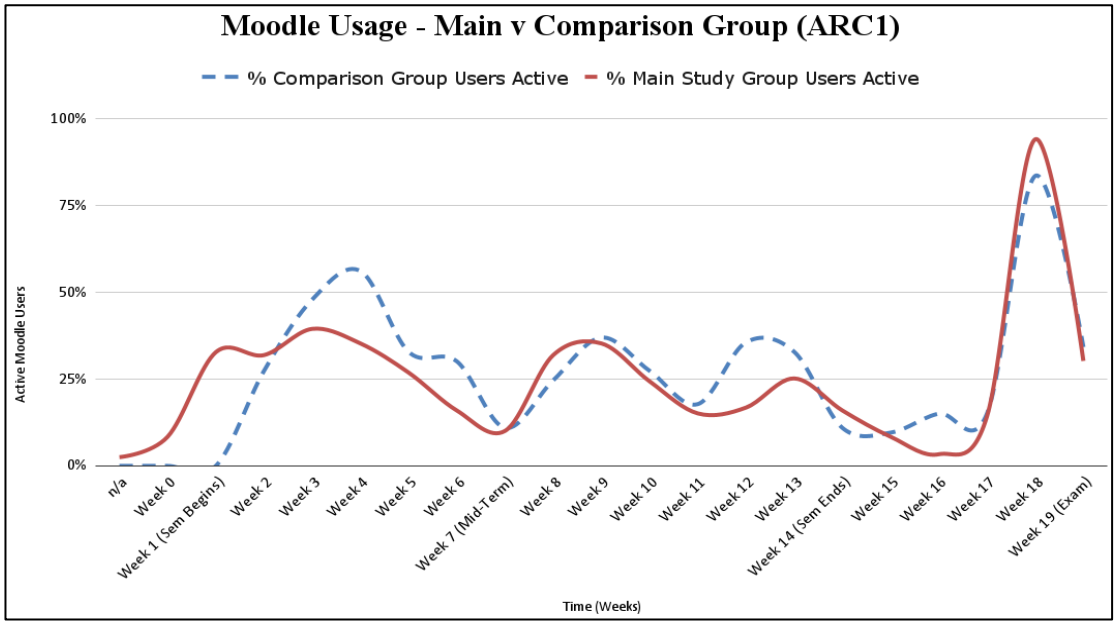


Figure 13. Moodle Usage - Main v Comparison Group [ARC1]

Figure 13 shows the weekly Moodle usage trends for both the Study Group and the Comparison Group during ARC1. The data reveal similar patterns of engagement across both groups. This suggests that simply participating in the study did not significantly influence overall Moodle usage. The slight differences observed, such as the higher spike in Week 3 for the Comparison Group, could be attributed to variations in other course-related activities, such as engagement with practical lab sessions or deadlines outside the study's scope. The marked increase in Moodle usage for the Study Group during exam preparation in Week 18 may relate to their engagement with quizzes provided in the study, positioning these quizzes as a potential factor in enhancing exam-focused activity on the platform. Overall, the week-to-week differences fall within the range typically expected between two randomly assigned groups, reinforcing that any

impact on academic outcomes likely stems from study-specific interventions, such as the quizzes, rather than general Moodle use.

Quiz Data Analysis

This section explores the quiz data in more detail, examining patterns of engagement and quiz attempts among the 116 active students in this research cycle. Among these students, the maximum number of quiz attempts was 10, with an average of 1.22 attempts per student. Many students did not attempt any of the quizzes. Additionally, some learners clicked on the quiz link and navigated to the quiz page but did not attempt any questions, suggesting varying levels of engagement.

A summary of the statistics for each quiz, including the date issued, number of questions, and number of attempts, is outlined below.

Quiz	Attempts	No. of Clickthroughs	No. of Students	Average number of attempts / student (CTR)	% of students on module	No. of Questions	Date Issued
Quiz 1	69	16	47	1.47	41%	41	Week6
Quiz 2	50	10	35	1.43	30%	34	Week6
Quiz 3	13	3	11	1.18	9%	18	Week9
Quiz 4	23	2	18	1.28	16%	22	Week12
Total	186						

Table 1. General Quiz Data [ARC1] (N=116)

Note: Attempts refers to the number of times each quiz was completed. No. of Clickthroughs represents instances where students accessed the quiz page without completing it, while No. of Students indicates the unique students who completed each quiz at least once.

The table shows a decline in student participation over time, with Quiz 1 having the highest completion rate (40.5%) and subsequent quizzes displaying fewer attempts. Of the 61 participants who completed at least one quiz, all but one also undertook the continuous assessment and final exam. The one exception logged in briefly during Week 13 to complete Quiz 1 three times and subsequently failed the module, standing out as an outlier in the dataset.

Early quizzes, notably Quiz 1, likely benefited from initial promotion, whereas later quizzes may not have been endorsed as strongly, contributing to the drop in engagement. However, a slight increase in attempts for Quiz 4 suggests renewed interest as the semester concluded and exam preparation intensified. This observation corresponds with exam performance data, indicating that students engage most with content they expect will be directly relevant to their assessments.

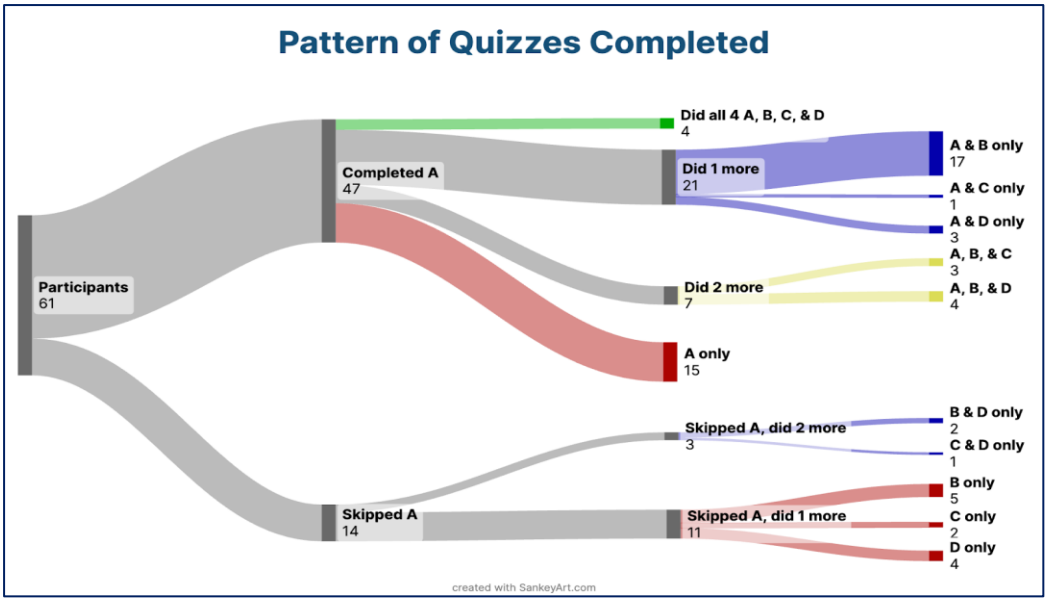


Figure 14. Patterns and Flows of Quiz Attempts [ARC1]

** Note: Red denotes users who have only done one quiz, Purple denotes users who have only done two quizzes, Yellow denotes users who have done three quizzes, Green denotes the 4 users who did all four quizzes.*

The Sankey diagram in Figure 14 depicts the flow and patterns of quiz completion among 61 participants across four quizzes (A, B, C, and D). This diagram is a useful visualisation of the distribution and patterns of quiz completion within the study's participants. It summarises where most participation lies and how many participants engaged with each individual quiz, as well as the combinations thereof.

It shows that a majority of participants (47 out of 61) started by completing Quiz A, while 14 participants skipped Quiz A entirely. Among those who completed Quiz A, 15 participants stopped after Quiz A, 21 completed Quiz A and one more quiz, seven completed Quiz A and two more quizzes, and four participants completed all four quizzes. For participants who skipped Quiz A, three went on to complete two other quizzes, and 11 completed one other quiz. The right side of the diagram details the specific combinations of quizzes completed by participants, indicating that some completed all four quizzes, while others completed various combinations of two or three quizzes, with or without Quiz A. Additionally, a few participants only completed one of the quizzes B, C, or D.

The data reveals the diversity in quiz engagement, showing that while many participants engaged with multiple quizzes, a significant number only engaged partially, and only a few focused on quizzes other than Quiz A. This highlights the varying levels of quiz participation, and the different paths students took in engaging with the quizzes.

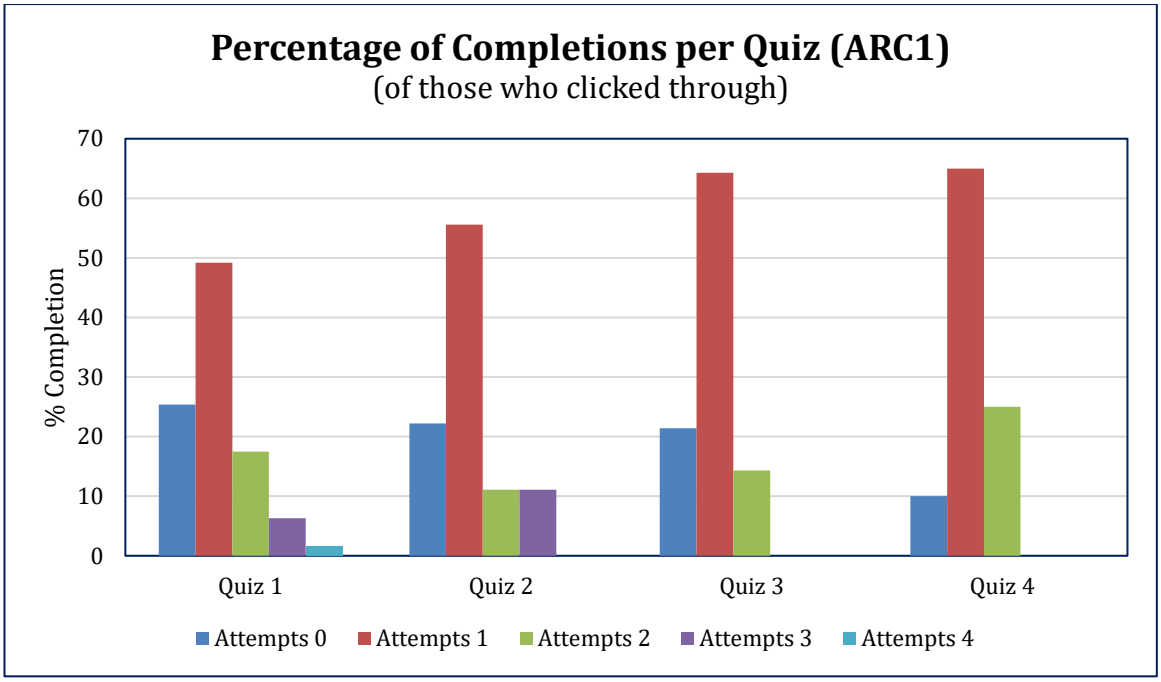


Figure 15. Percentage of Completions per Quiz [ARC1]

Of those students who clicked onto the quiz, we can see in Figure 15 that most of them completed the quiz, i.e., answered some questions and submitted their responses to be graded. However, there was a sizable group of students who clicked the link, arrived at the quiz, but did not make an attempt to answer any of the questions.

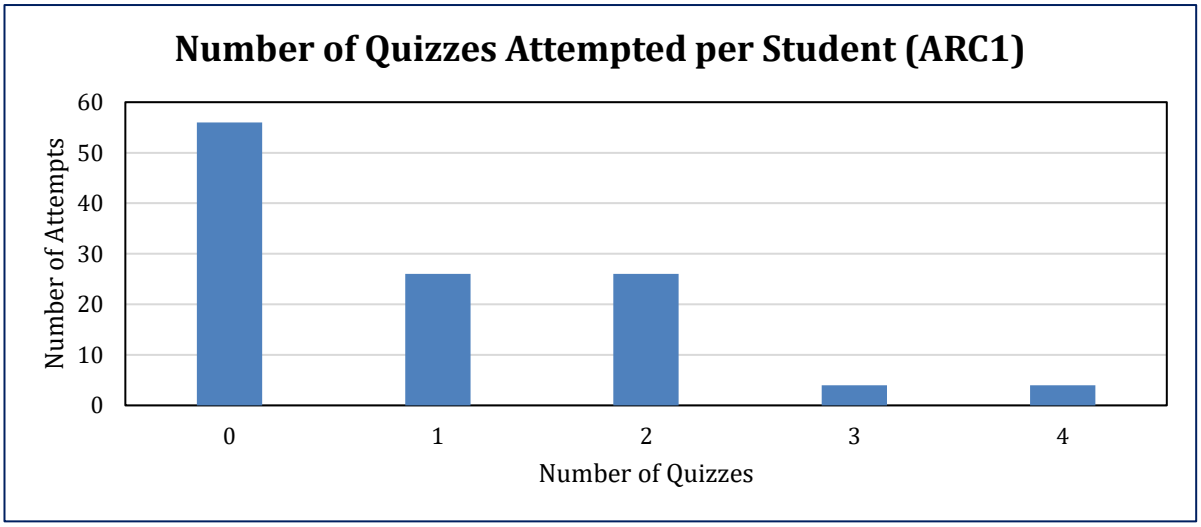


Figure 16. Number of Quizzes Attempted per Student [ARC1]

Figure 16 shows the number of quizzes attempted per student. In total, 48.3% (n=56) made no attempt at any of the quizzes. 22.4% (n=26) attempted one quiz, 22.4% (n=26) attempted two quizzes, 3.4% (n=4) attempted three quizzes and 3.4% (n=4) attempted all four quizzes.

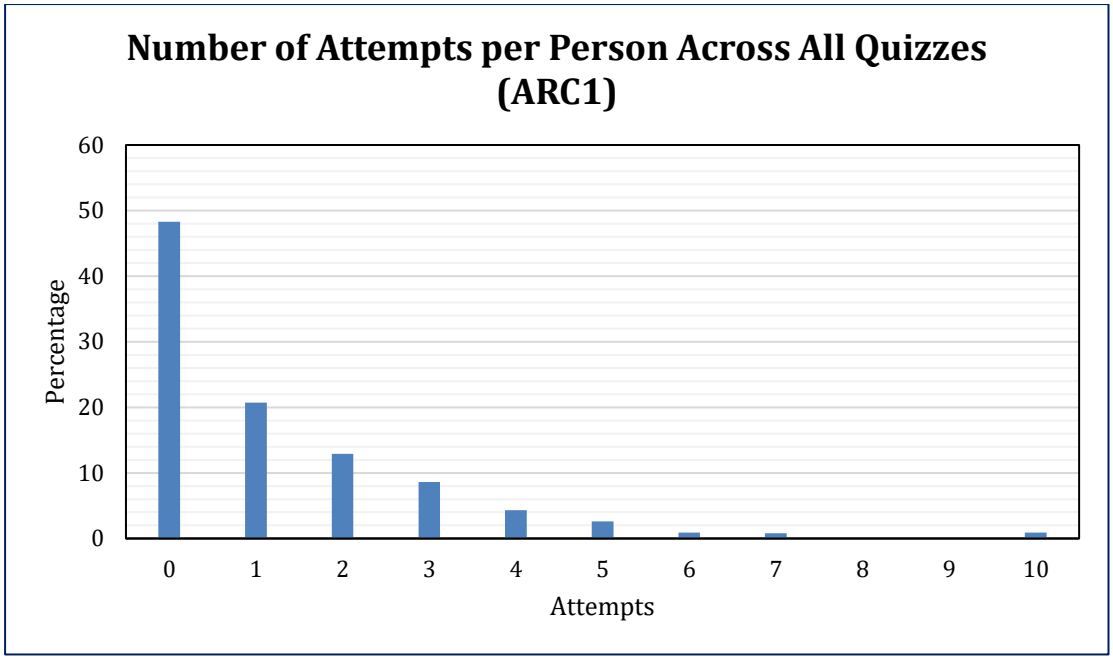


Figure 17. Number of Attempts per Person across all Quizzes [ARC1]

Unlike Figure 16, Figure 17 shows the total number of attempts across all four quizzes in this cycle. It shows that a small number of students attempted quizzes more than once. We can see that nearly half the class (48%, n=56) have not attempted any quizzes. Almost a further half of the class (47%) attempted the quizzes one to four times, with only a handful of students attempting quizzes five or more times.

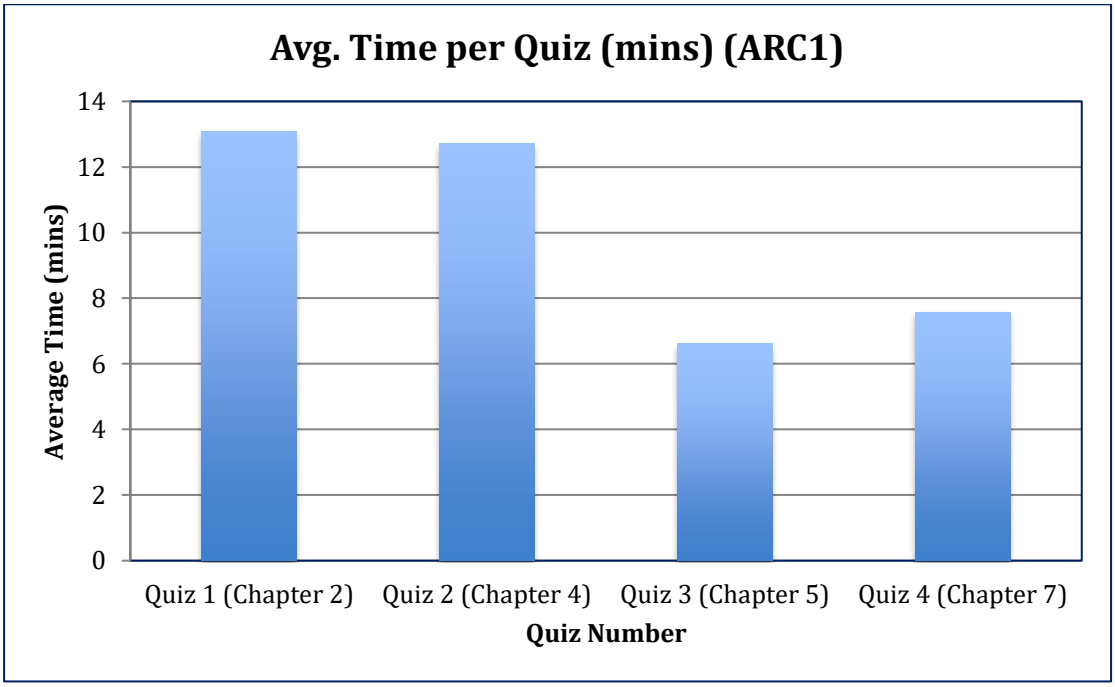


Figure 18. Average Time per Quiz [ARC1]

The average time spent on Quiz 1 was 13 minutes, on Quiz 2 was 12 minutes, on Quiz 3 was 7 minutes and on Quiz 4 was 8 minutes. The average time spent on each quiz attempt went down with each subsequent quiz, until the last one when it went back up. The average time dropped significantly for the third and fourth quizzes. This is mainly because there were fewer questions in those quizzes. These data are relevant when we later look at reasons the students gave for not attempting the quizzes, where one of the main reasons was that they had a lack of time.

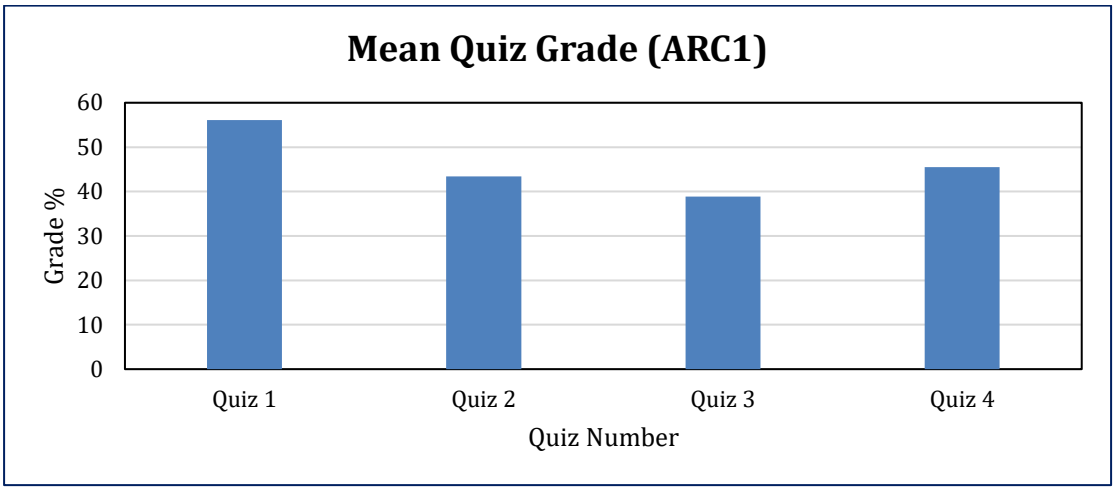


Figure 19. Mean Quiz Grade [ARC1]

Figure 19 displays the mean grades for the four quizzes in ARC1. The mean grade for Quiz 1 is 56%, for Quiz 2 it is 43%, for Quiz 3 it is 39%, and for Quiz 4 it is 46%. These figures indicate that the quizzes were quite challenging, with none of the average scores reaching exceptionally high levels.

I included this graph to illustrate that the quizzes were designed to be neither too easy nor too difficult, aiming for a balanced level of challenge. The mean grades suggest that students found the quizzes demanding, which is necessary for encouraging meaningful engagement and learning. However, it raises an important consideration in relation to the link between performance and motivation There is a potential impact on student motivation depending on how they perceive their performance. If a student achieves a higher grade, it might encourage them to attempt more quizzes, perceiving the task as achievable and rewarding. Conversely, if the grades are perceived as too low, it might discourage further attempts, leading students to believe the quizzes are overly difficult. As the quizzes were to be refined in subsequent cycles, it was worth trying to figure out the ideal mean grade that balances challenge and motivation, ensuring students remain engaged and motivated to continue their learning journey.

Correlation Data (Attendance, Exam Results, Quiz Attempts)

There were some relationships between quiz attempts and attendance and between quiz attempts and overall grade. More quiz attempts were associated with higher attendance and higher grades. However, these associations are small.

Variable	1	2	3	4
1 # of Quiz attempts	1			
2 Attendance	.255*	1		
3 Theory Grade	.140	.111	1	
4 Overall Grade	.205*	.294**	.804**	1

Table 2. Correlation: Quiz Attempts, Attendance and Academic Performance [ARC1] (N=112)

*Note: * correlation significant at 0.05 level, ** correlation significant at 0.01 level.*

The Spearman's Rho analysis shows the relationships between quiz attempts, attendance, theory grades (what a student achieved in their end of term exam), and overall grades. There is a significant but small positive correlation between the number of quiz attempts and attendance with r_s (110)=.255, p<.05, and overall grade r_s (110)=.205, p<.05. Although weak, there is a tendency for a link between quiz participation and attendance, as well as overall grades. This pattern of a small correlation continues with attendance and overall grade with r_s (110)=.294, p<.01, indicating a tendency that better attendance is associated with higher grades. Contrary to the initial analysis, the data reveal no significant correlation between the number of quiz attempts and theory grades, reinforcing the conclusion that quiz attempts do not necessarily impact theoretical understanding directly. This is illustrated visually below by plotting attendance and grades relative to the number of quiz attempts (Figure 20) and number of quizzes attempted (Figure 21).

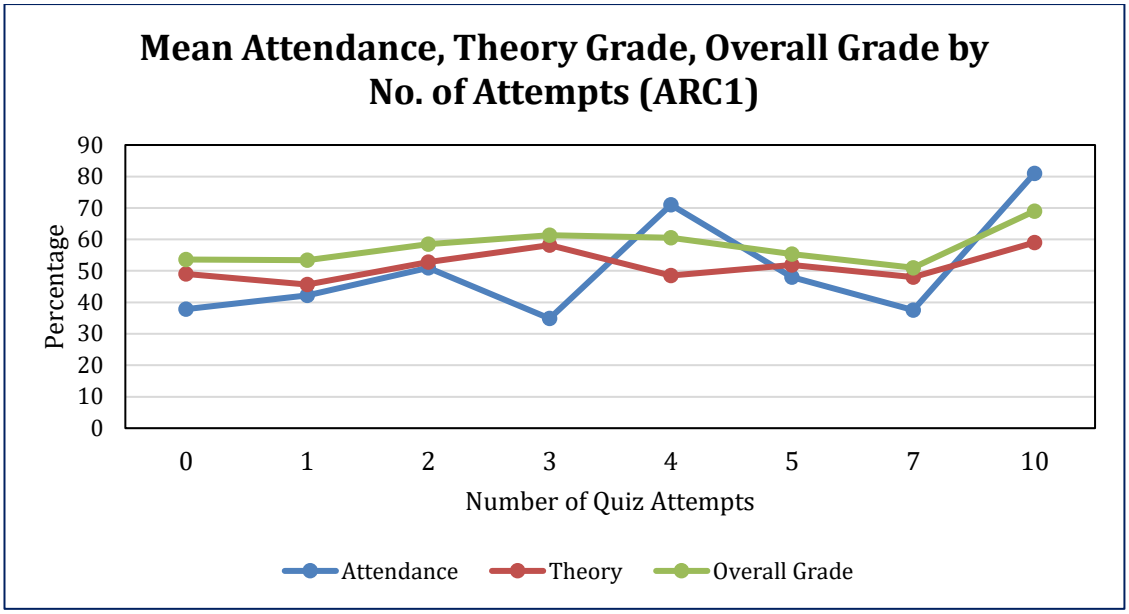


Figure 20. Attendance and Grades Relative to Quiz Attempts [ARC1]

Figure 20 analyses the relationship between quiz attempts, attendance, and academic performance, focusing on the theory grade, which constitutes 70% of the overall module grade. The analysis reveals an inconsistent relationship between quiz attempts and theory grade (final exam score), indicating that increased quiz engagement does not directly translate to improved exam performance. However, a noticeable improvement in the overall grade is observed, from a mean of 53.64 without quiz attempts to 69 with ten attempts. This suggests that frequent quiz attempts may contribute to enhanced academic performance, particularly when considering the overall grade, which also incorporates a practical component (30%) assessed independently of the quiz content.

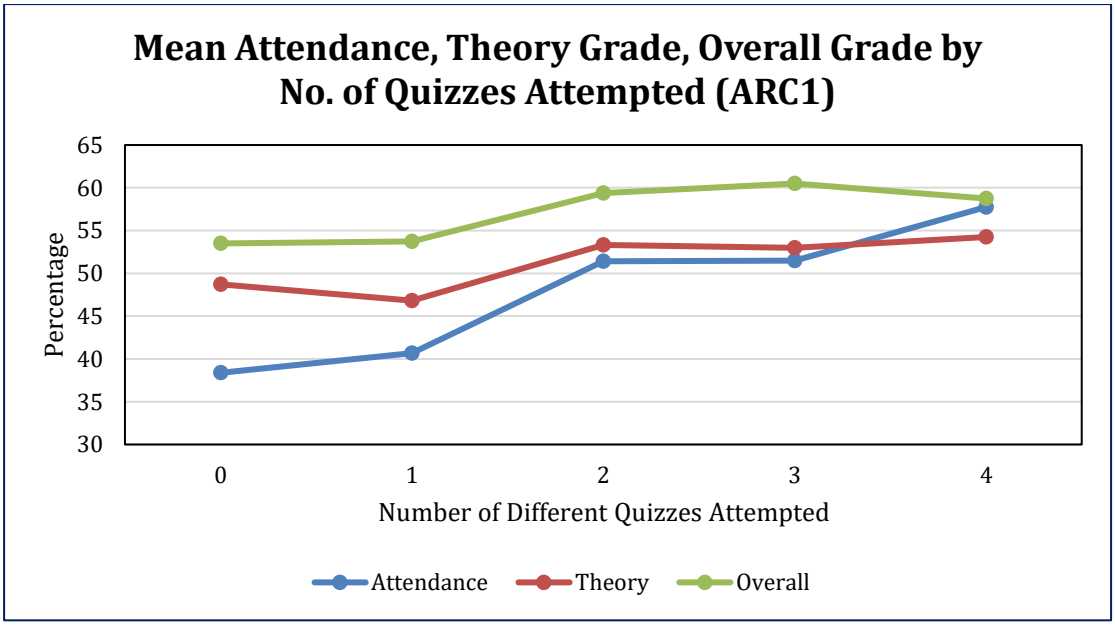


Figure 21. Correlation: Attendance and Grades Relative to Quizzes Attempted [ARC1]

Figure 21 shows the average attendance, theory grade, and overall grade relative to the number of quizzes attempted. As quiz attempts increase, attendance shows an upward trend, rising from 38.38 with no attempts to 57.75 with four attempts. This suggests a positive association between quiz participation and attendance. The theory grade also shows a slight increase, from 48.72 to 54.25, with more quiz attempts. However, the overall grade increases up to three attempts and then slightly decreases. This indicates that the quizzes may impact the theory component more consistently than the practical component, which is assessed separately.

While some relationships show positive trends, the impact of quiz attempts on attendance and overall grades, although statistically significant, remains limited. These findings suggest a potential benefit in encouraging quiz participation to improve attendance and possibly enhance theory understanding. However, further investigation is needed to draw stronger conclusions due to the complex nature of student performance and the limited sample size at higher numbers of quiz attempts.

End of Semester Survey Data

In addition to the pre-intervention and mid-semester surveys discussed earlier, an End of Semester Survey was conducted after the ARC1 students' results had been released. The purpose of this survey was to gather further insights into how participants engaged with the TEFAs throughout the semester, especially given the increase in quiz attempts since the mid-semester survey. The timing of the survey was deliberate, as students had received their Semester 1 exam results by then, allowing them to reflect on their TEFA participation and its potential impact. It was expected that this reflection, informed by their exam performance, would provide valuable insights into their perceptions of the TEFAs.

Given the generally positive responses to the last two survey questions on helpfulness (helpful-useless) and innovation (conservative-innovative) in the mid-semester survey, these questions were not included in this end of semester survey. I believed that students would continue to perceive the quizzes as helpful, since they viewed them as both supportive and innovative compared to their previous experiences. Additionally, I wanted to ask more detailed questions about the helpfulness of the quizzes in the end-of-semester survey. Therefore, three new questions were introduced to assess the perceived effect of the TEFAs on exam preparation, engagement with the module material, and actual exam grades. While there is always the possibility that perceptions

could shift in future iterations, I considered these aspects sufficiently covered by the new questions. However, the other six questions in the Likert-type scale were repeated in this end of the semester to gauge whether students perceived any improvements in the quiz design after changes were implemented based on these findings.

A total of 64 students completed that survey, with approximately 70% of respondents (45 students) having completed at least one quiz, and around 30% (19 students) having not completed any quizzes by that time. It was noted that all of the respondents who had not attempted any quiz expressed their intention to do so in Semester 2.

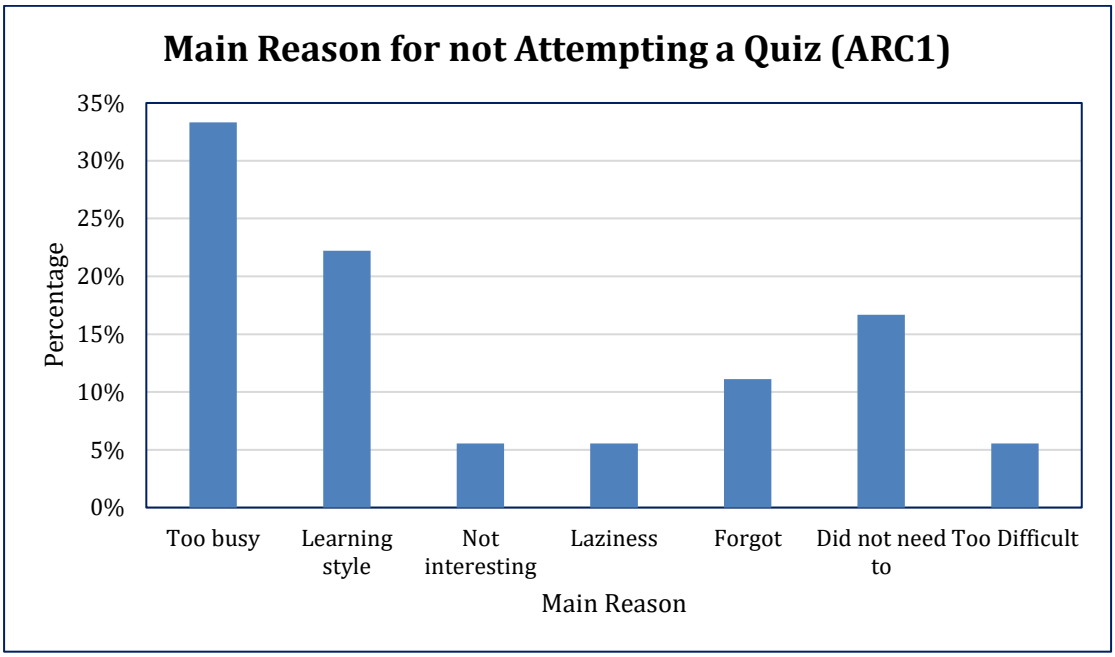


Figure 22. Reasons for Not Attempting a Quiz [ARC1 End of Semester Survey]

As part of the examination of student engagement with quizzes in Semester 1, participants who did not attempt any quizzes were asked to provide reasons for their non-participation. Their responses [n=18] were categorised into seven distinct themes, as depicted in Figure 22. The predominant reasons for not engaging with the quizzes included being too busy, cited by 33% of the respondents, a mismatch with their learning approach (22%), a perceived lack of necessity (17%), and simply forgetting to do them (11%). Additionally, individual feedback revealed that one student found the quizzes too difficult, and another did not find them interesting.

Conversely, comparing the reasons above to the 45 survey respondents who did engage with the quizzes, there was a varied level of participation across the four quizzes offered: 34 students completed Quiz 1, 28 tackled Quiz 2, 13 managed to complete Quiz 3, and 18 finished Quiz 4. Notably, a significant majority (91%) of these respondents,

representing 70% who had attempted at least one quiz, expressed their intention to engage with quizzes in Semester 2. In terms of frequency, 78% of these respondents reported completing a quiz 1-2 times on average, while 20% attempted a quiz 3-5 times, and one respondent stood out by completing a quiz more than nine times. This variance in engagement and intention to continue participating in quizzes into the next semester offers further insights into student behaviours and attitudes towards quiz-based learning activities.

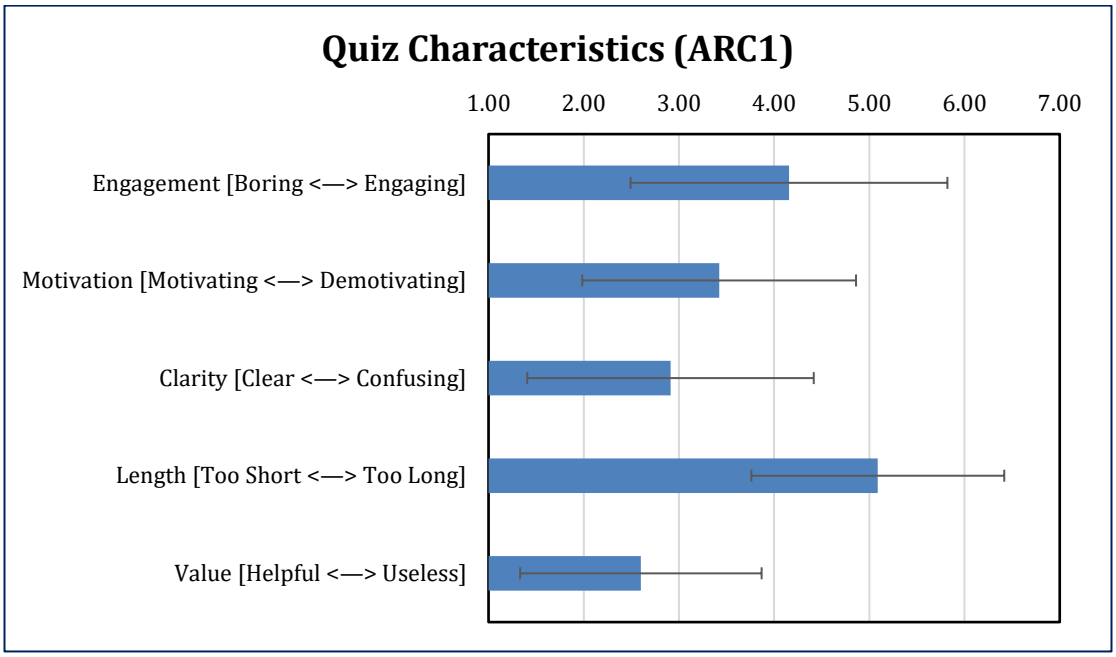


Figure 23. Quiz Characteristics (n=45) [ARC1 End of Semester Survey]
Note: Scores indicate averages on a 7-point Likert-type scale. Error bars indicate ±1 SD

In the end-of-semester survey, which used the same 7-point Likert-type scale and questions as the mid-semester survey, the findings offer a view of how students' perceptions of the quizzes evolved over the course of the semester. Engagement had an average rating of 4.16 (SD = 1.66), with 42% of students leaning toward finding the quizzes "Engaging" (ratings 5–7) and 36% leaning toward "Boring" (ratings 1–3), both slightly lower than the corresponding percentages at mid-semester (47% and 41% respectively). This suggests a modest shift toward neutrality, as 22% of students selected a neutral rating (4).

Motivation maintained a generally consistent pattern compared to mid-semester, with an average rating of 3.42 (SD = 1.44) versus the mid-semester figure of 3.59. Here, 44% found the quizzes motivating, 22% found them demotivating, and 33% selected a neutral rating. Despite the dip in the mean, these proportions indicated only a slight

change in the students' perception of whether the quizzes motivated them to be more engaged with the coursework in general.

Clarity showed a more pronounced improvement than the previous measures. Its average rating was 2.91 (SD = 1.50), with 71% of students rating the quizzes as "Clear," up from 65% at mid-semester, and only 15% rating them as "Confusing," down from 29%. A small contingent of 13% remained neutral. These figures pointed to a more uniform sense of understanding, suggesting that adjustments to quiz design or instructions may have resonated with students by semester's end.

Quiz length emerged as a lingering concern. With an average rating of 5.09 (SD = 1.33), 59% found the quizzes "Too Long," a slight rise from the 56% observed at mid-semester, and 6% found them "Too Short," a modest increase from 0% previously. One-third of students remained neutral. These minor shifts do not appear to fundamentally alter the prevailing sentiment that quizzes are lengthy.

Perceived value remained a strong point, averaging 2.60 (SD = 1.27). Of the students surveyed, 77% considered the quizzes "Helpful," 9% found them "Useless," and 13% were neutral, paralleling the pattern seen in the mid-semester survey, when helpfulness was rated at 2.18. While the average rating shifted slightly upward, the overall perception of the quizzes as beneficial appeared stable.

Taken together, these results reflect incremental changes in key areas. Engagement and clarity improved somewhat, while motivation remained largely unchanged. Quiz length persisted as a concern, with a small increase in students finding them too long. The sustained positive perception of the quizzes' value reinforces their role as a beneficial component of the course. However, the data also indicated opportunities for further refinement in future iterations to address persistent issues around quiz length and improve student motivation.

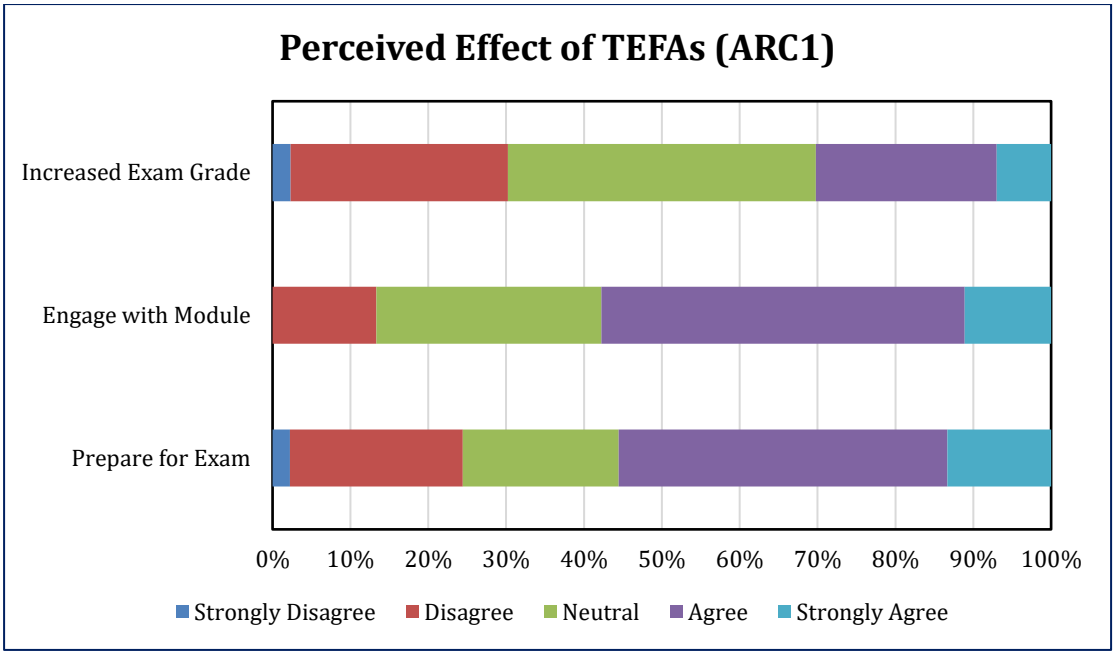


Figure 24. Perceived Effect of TEFAs on Exam Preparation, Engagement, and Grades [ARC1 End of Semester Survey]

In this survey, three additional questions were introduced to measure the perceived impact of TEFAs on exam preparation, engagement with the module material, and actual exam grades. The results indicated a positive trend in the perceived benefit of TEFAs for exam preparation, with 56% of the 45 respondents affirming (agreeing or strongly agreeing) that TEFAs facilitated their preparation for the final exam. In contrast, 24% did not see this benefit (disagreed or strongly disagreed), and the remainder were neutral on this matter.

Furthermore, the TEFAs were seen as beneficial for engaging with the module material, with 58% of respondents concurring (agreeing or strongly agreeing) and only 13% dissenting. A notable 29% of the participants remained neutral, indicating that while a majority found TEFAs helpful for engagement, a significant proportion were unsure.

The influence of TEFAs on actual exam grades produced the most varied responses. An equal proportion of respondents, 30%, either agreed or disagreed that TEFAs had a positive impact on their exam grades, showcasing an even split in opinion. Notably, 40% of the respondents remained neutral, suggesting a significant level of uncertainty or a lack of perceived direct correlation between quiz completion and exam grade improvement. These data suggested that while TEFAs are generally perceived as a useful tool for exam preparation and module engagement, their direct influence on improving exam grades is less clear-cut among the student cohort.

Responses to the Open-Ended Survey Questions

The end-of-semester survey included several open-ended questions aimed at understanding students' engagement with the quizzes and identifying areas for improvement. The questions asked were: "If you did not attempt a quiz in Semester 1, can you outline the main reason(s) why you did not?" (18 responses), "What features of the quizzes did you find most helpful?" (35 responses), and an invitation to add other comments (13 responses). The analysis highlighted issues related to time management and study prioritisation, ease of access and user experience, and motivation and perceived value. These insights provide a comprehensive view of student engagement with the quizzes and point to specific areas for enhancement in the next research cycle to improve educational outcomes.

1. Time Constraints and Academic Prioritisation

These factors emerged as important issues for the students in terms of their participation with the online quizzes. A significant number of respondents pointed to the demanding nature of their academic schedules as the primary hindrance. Comments such as "*To be honest had a lot of other college work to do,*" and "*I simply did not have time to do the quizzes,*" underline the reality that these quizzes are competing with numerous other academic responsibilities. This seemed to become more of an issue when students perceive the quizzes as a considerable investment of time. Comments like "*very time-consuming,*" and "*shortage of time due to voluminous workload of 1st semester in various subjects,*" were expressed. These statements highlighted the challenge students face in allocating time to learning activities that, while they may be potentially beneficial, are not seen as immediately crucial to their academic success. Remarks like "*I didn't have time around my busy work timetable,*" for not attempting any quizzes, highlighted the conflict between the perceived value of the quizzes and the other things they have going on, like other coursework, part-time jobs or other commitments.

2. Technological Accessibility and Digital Comfort

Two factors that played a critical role in determining how these students engaged with the quizzes, were how accessible the technology was, and the individual's comfort level with using technology. The survey responses highlighted that not all students found it easy to adapt to digital study methods. The student who responded, "*Find it hard to study online or on a computer,*" speaks to the digital divide that can exist within a

student body. This and similar statements point to a broader issue where the efficacy of online learning resources is contingent upon students' ease with technology.

This insight is further supported by another student's straightforward remark about the availability of the quizzes, as they "*Do not realise they were online,*" which not only reflects a gap in communication but also suggests that some students may not be regularly accessing the online platforms where such resources are available. The comfort level with technology can vary significantly among students, with some being adept at navigating digital environments while others may struggle with basic tasks.

3. Learning Preferences and Study Habits

The survey responses revealed that a notable portion of the student population had a strong inclination towards conventional study techniques. This is summed up in the response, "*I prefer to write out answers and learn them that way.*" This reflects a personal preference for physical notetaking and also a broader hesitation to embrace digital learning tools that deviate from this method. Another student's comment, "*It was quite different to my usual study routine. I like consistency,*" emphasises the importance of routine and familiarity in the learning process to students like this. These comments may have indicated that online quizzes, while innovative, might unintentionally disadvantage students who perform better with traditional learning methods or who may choose not to engage with these digital approaches.

4. Effectiveness of Quiz Design

The student comments suggest that the effectiveness of the quiz design is a decisive factor in how students perceive and interact with online quizzes. The survey responses make it evident that students value well-structured and informative quizzes. One student remarked that the quizzes were "*Clear and easy to follow. Informative*," suggesting that clarity in design and content can enhance the learning experience.

However, while students recognised the value of quizzes in their learning process, there was a clear preference for brevity and relevance. Responses such as "*Shorter quizzes,*" or "*Make the length of the quiz's shorter,*" reflect a common sentiment that while quizzes are useful, their length can be a barrier to engagement. Students seemed to prefer quizzes that are not only informative but also succinct, allowing them to efficiently test and reinforce their knowledge without becoming overwhelming.

There are indications from the findings that this preference for concise quizzes stems from the already significant demands on students' time and the cognitive load involved

in processing large amounts of information. When a student suggested making the quiz *"shorter so they take less time to complete,*" it implies a need for quizzes that students can integrate smoothly into their study routine without feeling overburdened. This preference may also suggest shorter attention spans, potentially influenced by digital devices and social media, where brief, rapid interactions are common.

The insight here is that the design and content of quizzes need to be carefully considered to ensure they are engaging and support students' learning goals effectively. This might involve breaking down larger quizzes into smaller, more focused elements that students can complete incrementally, or ensuring that every question directly relates to key learning outcomes and exam preparation. Again, this is an important consideration for the next research cycle.

5. Feedback Mechanisms and Learning Reinforcement

Students' responses from the survey show the importance they place on understanding not just what the correct answers are, but why they are correct. One student highlighted the value of this approach, saying, "*it gave an explanation as an answer, and why it is the answer and not another answer*." The immediacy of such feedback was also a significant factor, with students appreciating the ability to see "*the correct answer at the end,*" and to "*attempt them more than once*," which one student said, "*helped me remember previous lectures/notes I had read which made it easier to remember key information for my exam in January*." These direct quotes illustrated the role of quizzes not only in assessing knowledge but also in contributing to the learning process by clarifying misunderstandings and reinforcing correct information.

Furthermore, the opportunity for repeated attempts was mentioned as beneficial for learning. For students, the process of attempting quizzes, receiving feedback, and trying again allows them to actively engage with the material and to learn from their mistakes in a low-stakes environment. This was summarised by a student who valued the feature that "*When answered incorrectly, the answer appears at the end of the quiz,*" which helps to consolidate their understanding of the content.

6. Awareness and Perceived Relevance

The responses indicated that non-participation often came from simply not knowing about the quizzes or not understanding their importance. For instance, one student admitted, "*I forgot about them,*" which may imply that there were not reminders about the quizzes by me or I could have used other communication channels. Another

student's response, "*Felt I didn't need to,*" potentially reveals a gap in conveying the potential benefits that these quizzes offer. These comments suggested that quizzes were not always front and centre in the students' minds as a part of their study regime. This points to a possible oversight in the way quizzes were presented and integrated into the course design. In considering the design of the second research cycle, there is a clear need for these tools to be more prominently featured within the learning pathway, perhaps through regular reminders or by embedding them within mandatory coursework. Linked to this, another learning to be applied next cycle is the perception of the quizzes' relevance, or lack thereof, has a direct impact on engagement levels. If students do not see a clear link between the quizzes and their academic goals, such as exam success or mastery of course content, they are unlikely to prioritise them.

7. Motivation and Subject Interest

Motivation and subject interest were key drivers for student engagement with online quizzes. Direct quotes from the survey, such as a student admitting to "*Laziness,*" or another stating that "*The topics are not interesting for me,*" pinpoint the need for more engaging content and motivational strategies. To counteract this lack of engagement, the incorporation of gamification elements or rewards could be considered for the next research cycle. Making quizzes more relevant to students' interests and clearly communicating the benefits, such as how they "*could be of good benefit this semester because I want to get a higher grade,*" may also help in motivating students to participate. These strategies could make quizzes not only a learning tool but also an integral, valued part of the study process.

8. Strategic Study Choices and Exam Preparation

Finally, the way a student prepares for the exam and the strategic choices they make over the semester are highlighted in the responses as significant considerations. The survey comments indicate that students are deliberate in how they allocate their study time, opting for methods that they believe will yield the best results for exam success. A student's choice to "*Study the notes and book instead of going through quizzes,*" reflects a calculated approach to studying, wherein the perceived most efficient path to exam readiness is chosen. This choice is influenced by their past experiences and outcomes, as another student noted the direct benefit of such strategic studying: "*What came up on a quiz, I studied for exam and the answer I studied came up*."

To emphasise this link, a tactic for a future action research cycle might consider integrating direct quotes from students about the benefits of quizzes into their course materials. For example, the student who acknowledged, "*The quizzes would be of good benefit this semester because I want to get a higher grade,*" provides a testimonial to the effectiveness of quizzes in exam preparation. Furthermore, an outcome for the next round of research could be to provide data or evidence showing the correlation between quiz participation and exam performance to reinforce the strategic value of quizzes.

Focus Group Findings

The following are the key insights gleaned from the focus group analysis, which highlight new results as well as verifying the findings from other research activities:

1. Variation in Quiz Completion

It was evident from the quantitative data on quiz completion that there were differences in levels of engagement and the number of quizzes completed. This pattern was also reflected in these focus group discussions, where there were varying levels of commitment and diverse learning approaches among students. The findings suggested that the variation in quiz completion rates might reflect time constraints beyond academic obligations, as many students juggle additional commitments. For example, one participant said, *"To be honest had a lot of other college work to do"* (FG1Speaker1), highlighting that competing priorities can detract from time dedicated to quizzes.

External responsibilities, such as work or family, limited some students' capacity to complete quizzes, but the findings also indicate an element of personal responsibility. A student comment, *"I didn't have time around my busy work timetable"* (FG1Speaker4), reflects that students make choices in allocating time. This reinforces the idea that quiz engagement is influenced by both external commitments and individual decisions, rather than being solely a course-related issue.

Additionally, one participant pointed out their high level of quiz interaction: *"I did it like two or three times, for revision."* (FG1Speaker7) This confirmed that some students not only completed all available quizzes but also re-attempted them, demonstrating how quiz usage can vary significantly across the group.

2. Participant Device Preference for Quizzes

A preference for certain devices, such as laptops or PCs, over smartphones was evident among the students. They reported that the larger screens and usability of laptops and

PCs were favoured because of their suitability for quiz-taking. This preference was clearly articulated by several students, highlighting the importance of device choice in the context of academic quizzes. One student explicitly expressed their preference, stating, *"I prefer to do them on the laptop"* (FG1Speaker1). Another student echoed the preference for laptops, but added a location-agnostic perspective: *"It doesn't matter where"* (FG1Speaker1).

The larger screen on the laptop is directly cited as the root cause of this preference: *"...looking at a bigger screen, it's just handier"* (FG1Speaker2). Some cited a preference for their PC as well, illustrated by a participant who said, *"I differ, I did it in my PC and I prefer to do it in my PC"* (FG1Speaker3). Another student stated plainly: *"You get more work done on the laptop"* (FG1Speaker4). It is not always clear if students use the terms laptop and PC interchangeably, but they consistently highlighted the larger screen size as a key factor in making quizzes easier to complete.

Such insights are crucial for understanding how the physical aspects of technology can affect the effectiveness and accessibility of educational tools like quizzes. Recognising these preferences guided my planning for the next research cycle in making more informed decisions about the technological infrastructure to support students' learning experiences.

3. Influence of Device on Participant Concentration

A significant theme that emerged was the influence of the choice of device on students' concentration and engagement with the quizzes. Many students stated that their focus while taking quizzes was affected by the type of device they used, particularly noting the increased likelihood of distractions when using smartphones.

One student emphasised this point about distractions associated with smartphones, saying, *"Yeah, you get too distracted on the phone anyway"* (FG1Speaker7). This comment directly addresses the issue of focus, indicating that the nature of smartphones, possibly due to their multifunctionality and constant connectivity, can lead to a fragmented attention span. Another student added, *"Yeah, you get a message or something and you leave the quiz"* (FG1Speaker4), providing a concrete example of how incoming alerts can interrupt the flow of concentration when using a phone.

However, the conversation also addressed a separate but related issue of ease of use on different devices: *"Even on the iPad it's easier to do it on a tablet, it's easier to do it on the laptop or the PC than do it on a smaller device"* (FG1Speaker4). One participant

observed, *"That screen is good because it's more readable because you are trying to gain something from that, maybe as a kind of revision"* (FG1Speaker3), which further emphasised the practical advantages of larger screens and interfaces.

This conversation amongst the students clearly highlights a common concern regarding the use of smartphones for academic purposes like quizzes. The tendency for increased distractions when using smartphones pointed to a need for careful consideration of the most suitable devices for educational activities.

4. Impact of Quiz Length on Students

The discussion around the number of questions in the quizzes elicited mixed reactions among the students. While most agreed that the quizzes were lengthy, containing too many questions, some students saw this as beneficial for their learning, whereas others felt it was overwhelming. One student stated their view on the number of questions: *"Far too many"* (FG1Speaker1). Others in the focus group agreed with this view, simply confirming, *"Too many"* (e.g. FG1Speaker2). The feeling of being overwhelmed by the number of questions was echoed by a student who said, *"That's why I only attempted it [once], I just left it then"* (FG1Speaker4). This comment suggested that the sheer volume of questions could be demotivating or daunting for some students, leading them to disengage from completing the quiz and other quizzes.

However, not all students viewed the quantity of questions negatively. One participant offered a contrasting perspective, highlighting the educational value of the extensive questions: *"If there had been less questions, I wouldn't have learned as much because when I didn't know the answers you'd to go and look them up"* (FG1Speaker7), demonstrating how the extensive questions encouraged self-directed learning and research.

Others expressed a more complex perspective: *"I don't think it's too long but it cost me a lot of time to finish it"* (FG1Speaker3). In the same conversation, this participant acknowledged that *"I got bored in the middle of it … I just felt like it was going on"* (FG1Speaker3), which showed that while thorough coverage can be helpful, it can also be tedious if students lack sufficient time or focus.

These diverse perspectives here highlighted the subjective nature of quiz engagement. It suggested that the ideal number of questions in a quiz varies widely among students, depending on their learning approaches, preferences, and perhaps their familiarity or confidence with the subject matter. It also depends on how the students perceived the

quiz: can they escape the tendency to see it as a 'test' in favour of a learning opportunity?

5. Participant Preference for Immediate Feedback

The preference for immediate feedback in quizzes was a prominent theme in the focus group, with students expressing a clear preference for receiving instant responses to their answers. One student highlighted the importance of instant feedback, saying, *"Very, very helpful"* (FG1Speaker2), underscoring the value they place on receiving immediate responses.

Another participant added, *"I think the instant feedback is just to have answers that are clear without having to write your essay … it's kind of like those, most of them were A, B, C or D so therefore you got it right or wrong"* (FG1Speaker6). In other words, students appreciated closed-ended questions for their quick turnaround in telling them whether their reasoning or recall is correct.

Overall, the students' responses suggested that instant feedback not only enhances the learning experience, but also contributes to a more efficient and engaging quiz format.

6. Appropriate Challenge Level of Questions

The difficulty of the quiz questions was another aspect highlighted in the focus group. Students generally found the questions to be well balanced in terms of difficulty, aligning well with the module's learning objectives. One student noted, *"They addressed the issue that we were trying to learn. Fair and focused"* (FG1Speaker4), suggesting that the questions were relevant and appropriately challenging. Another student emphasised that *"They weren't easy"* (FG1Speaker7), suggesting that while fair, they certainly required effort and understanding.

7. Engagement Relating to Subject Interest

The level of engagement with the quizzes appeared to be influenced by individual interest in the topic, suggesting a subjective element in the quiz perception. *"I wouldn't be a big fan of [the topic] … it wouldn't be the most interesting for me"* (FG1Speaker3), confirm that lack of interest in the subject matter affected their engagement with the quiz. Another participant shared a similar sentiment: *"…it wouldn't be the most interesting for me"* (FG1Speaker2). *"I think it does depend on your interest in the topic"* (FG1Speaker3) aptly captures how personal preferences influence commitment. These quotes collectively illustrate that student engagement with quizzes is strongly influenced by their interest in the subject matter. While the quizzes are acknowledged

as a valuable learning tool, the level of enthusiasm and commitment seems to vary depending on how intriguing or relevant the students find the topic. For this research, it would not be possible to change the module content, but attempts could be made to make it more engaging. The quizzes would be one vehicle to do this.

8. Quizzes as a Revision Tool

Students frequently mentioned how they used the quizzes for exam preparation. This perspective was supported by several direct quotes from the interview. One student clearly indicated the timing of their engagement with quizzes in relation to exams: *"Yeah, that's grand if you're doing it a few weeks before your exams but before the exams it was hard, like, it was hard to go through all the questions before"* (FG1Speaker6). The value of quizzes for revision and for clarifying and reinforcing subject matter was further emphasised in the following comment:

> *"Yeah, it's really ... because I get the clear vision of what is missing but not just that because it's a very big topic, very voluminous and it's all about everywhere, I say this and that, but when I did the quiz, it give me the clear picture of what it was really talking about in class. So, it's of a great help, so I did it before the exam and during the exam I just used it for revision again so ... so I attempted each of them like two or three times each."* (FG1Speaker4)

The quizzes' contribution to learning and preparation was also noted by a different student: *"I think they were a good idea to have them there and I kind of regret that I didn't spend more time on them. Because then I just kind of started my essays and learning them, probably would have been better off spending more time in the quiz."* (FG1Speaker1).

One student directly linked the quizzes to exam success, stating: *"There was a question that was literally nearly the exact same on the exam like"* (FG1Speaker5). Another elaborated on how discovering gaps in their knowledge prompted further learning*: "I found that I didn't know the answers to a lot of the questions ... that's when I learnt what I was trying to do, and I found that beneficial to me then when it came to the exam"* (FG1Speaker2).

These quotes collectively indicated that students frequently used quizzes for revision, particularly as a means to consolidate their learning and prepare for exams. The quizzes were seen as a useful tool for reviewing content, clarifying doubts, and reinforcing

knowledge, thereby playing a significant role in the students' exam preparation strategies. Knowing this set a positive foundation to build on for the next research cycle.

9. Motivation through Academic Credit

As discussed in Chapter 4, the quizzes did not form the basis of any final grade for the students, nor part of their continuous assessment grade. This may have proved to be a demotivating factor in terms of engagement for some learners, but it maintained the focus on self-driven learning. The concept of integrating quizzes into continuous assessment with allocated marks was popular among the students interviewed, as they believed it would significantly encourage more engagement. This perspective was supported by various comments, like *"A reward maybe for a continuous assessment, add marks for attempting the quizzes"* (FG1Speaker1). Another student agreed with this sentiment, reinforcing the idea that marks could serve as a strong motivator: *"Definitely. People would definitely take up on that if they knew they were getting marks."* (FG1Speaker4)

The notion that even a small allocation of marks could influence student behaviour was brought up: *"Even if it was only a small amount of marks"* (FG1Speaker2). One student elaborated on how marks could be integrated into the quiz format: *"Like even if you only had five per cent for it because it can be manipulated because you're doing it at home so therefore you can have the book in front of you or you can google your answer and that kind of thing. But it would incentivise it because it is a good tool for bringing things to mind, focusing your mind or just making you aware of them"* (FG1Speaker5).

Some participants also stressed the importance of when those marks should be available: *"I think if there was some way to incentivise them to be done at the end of a unit they would be of more value. You'd have more time to do them and then when you're going over them again as a revision tool"* (FG1Speaker4).

These quotes collectively highlighted a strong student preference for incorporating quizzes into the module's grading system, indicating that the potential for earning academic credit could significantly enhance student engagement and participation. The students felt that this approach would not only incentivise them to take the quizzes more seriously, but also encourage a deeper engagement with the material, enhancing the overall learning process.

These insights reflected the varied experiences and preferences of students in an academic context, pinpointing areas for potential refinement in quiz design and

implementation. The intention at this stage was that, for this module, there would be no marks allocated in future research cycles. However, the suggestion was considered.

Observational Notes and Addressing the Gap

Reflecting on the accumulated observational notes throughout the first cycle of the action research, it has become increasingly apparent that enhancing student engagement and feedback mechanisms in quizzes is a multilayered challenge. Initially, there was a noticeable shortfall in detailed feedback from students engaging with the quizzes during Semester 1. This observation led to a consideration of whether the survey conducted was comprehensive to the extent that students saw no need for additional commentary, or whether other barriers were at play, inhibiting their feedback.

The engagement levels across different quizzes varied significantly, with the latter quizzes showing lower completion rates, despite incorporating substantial improvements based on mid-intervention feedback. This finding suggested there was a need to consider whether the initial experience with the quizzes might have discouraged further participation.

The matter of the quizzes' length and complexity was also brought to the forefront, indicating a pressing need to carefully consider the optimal number of questions and their types. The intention behind this scrutiny was to streamline the focus group's exploration into making the quizzes more effective. However, the task of organising such a focus group presented logistical challenges, particularly in assembling a diverse group of participants, which was intended to include mature students, and both international and Irish students, to ensure a broad spectrum of insights.

A recurring issue was the confusion caused by the term *"elaborate"* in the questions of the last two quizzes, as highlighted by student number 48 and echoed in the end-of-semester survey feedback. This also pointed to the need for careful re-evaluation of language used in quiz questions to ensure clarity and accessibility for all students. Such insights emphasised the importance of language precision in fostering student engagement and effective assessment.

In order to address the gaps identified in my educational approach, especially in the areas of feedback and motivation, I engaged in specific professional development through participation in a series of Continuous Professional Development (CPD) seminars hosted by our Centre for Excellence in Learning and Teaching (CELT). The seminars covered "Principles of Good Feedback: Best Practice in Providing Feedback

to Students," "Motivation and Emotion: Understanding the Psychology of Feedback," and "Assessment and Feedback using Moodle Quizzes." These seminars were important for my understanding of these areas. They offered insights into the principles of effective feedback, understanding the psychological dimensions of feedback, and exploring the technicalities of Moodle quizzes. The knowledge and strategies gained from these seminars also directly informed the enhancements implemented in the subsequent quizzes, one important one being the need for more detailed feedback that goes beyond simply stating whether the answer is correct. This more comprehensive feedback to foster students' self-assessment capabilities, is supported by Nicol and Macfarlane-Dick's (2004) findings on facilitating self-assessment in learning. This approach was aimed not just at correcting misunderstandings but also at providing enriching information on the correct answers, thereby adding substantial educational value to the quiz experience. It became clear that providing feedback that went beyond the binary correct/incorrect responses could significantly enrich the learning experience by furnishing students with valuable insights into their learning progress and areas for improvement.

Moreover, I recognised the need to adapt feedback mechanisms to cater to the quizzes' formative assessment role. This shift was especially relevant given my previous experience primarily involved providing feedback on traditional forms of assessment like essays and presentations. The transition to leveraging quizzes as learning tools necessitated rethinking feedback strategies to maximise their educational impact.

A strategic goal of the study was to stimulate initial engagement with the quizzes, fostering a culture where students saw the inherent value in early and continued interaction with course content through these assessments. This strategy was underpinned by the belief that facilitating a student's first quiz attempt could significantly reduce apprehensions and motivate continued participation. Further reflections revealed the necessity to critically assess the design, promotion, and ongoing management of each quiz. This was informed by a combination of personal observations and analysis of various data sets, including survey responses, quiz data, and general engagement metrics.

The journal entries also detailed the considerable time investment required for the development and maintenance of the quizzes, highlighting the commitment needed to ensure their success. For me, the process involved a meticulous selection and refinement

of quiz questions, customisation to align with module content, and the provision of targeted feedback, especially for open-ended questions which demanded a higher investment of time and resources.

Task	Time Invested
Locate test-bank of questions	5 minutes
Refine test-bank from 90 questions to 20	6 hours
Customise several questions to module content	4 hours
Create four new questions	3 hours
Add correct answers & feedback to questions	4 hours
Add overall feedback	3 hours
Ongoing maintenance & management	6 hours
Total Time	26 hours and 5 minutes

Table 3. Quiz Development Time Invested [ARC1]

This table shows the intensive effort and time allocation necessary for the creation and upkeep of each quiz over the semester, totalling approximately three and a half days' worth of dedicated work per quiz. My time investment was critical in ensuring the quizzes were both relevant and effective as educational tools, reflecting the substantial commitment to enhancing student engagement and learning through formative assessment practices.

Conclusions and Planning for Next Cycle

The culmination of this first research cycle provides a comprehensive understanding of student engagement with the quizzes. Initial data suggested that the students were well-connected and engaged with Moodle from the outset. Their affirmative responses to using practice quizzes for module assistance indicated a positive attitude towards utilising technology for learning. Some of the major findings are outlined below.

Quiz Development

Quiz development proved to be a time-intensive endeavour, requiring consideration of various pedagogical elements, specifically within the domain of assessment for learning. Reflection on the design and usability of the quizzes highlighted two action

points: reducing quiz length and incorporating a variety of question types to cater to diverse learning preferences and to keep the assessment aligned with the principles of continuous improvement.

Quiz Uptake and Participation

The ARC1 findings indicated that improving quiz participation is a challenge. Consequently, to encourage attempts, it was necessary to explore diverse channels of communication, such as in-class announcements, Moodle announcements, personalised emails, and reminders. Additionally, it was evident from the participant comments that aligning quizzes with concise, exam-focused chapter summaries could provide students with a more streamlined and relevant study resource, potentially increasing quiz engagement. The rationale for increased participation is twofold: firstly, a personal belief in the quizzes' educational value, and secondly, the feedback from students who have recognised and articulated these benefits through surveys and focus groups.

Looking at the Moodle engagement data, it is clear the majority of activity and quiz attempts occurred at the end of the semester, just before the exam. Ideally, this would reflect a smoother curve, with students engaging with quizzes more consistently from the start and maintaining this engagement throughout the semester. To achieve this, the following research cycle aimed to implement more frequent reminders and structured integration of quizzes with coursework, aligning them closely with the curriculum timeline to encourage ongoing engagement.

Benefits of Quizzes and Student Motivation

The majority of students who undertook quizzes expressed a willingness to continue utilising them in the future. This intention was also mirrored by those who had not yet attempted any quizzes. It was clear from the feedback that addressing the reasons for non-participation is crucial. In the next cycle, strategies were explored to mitigate these real or perceived barriers, which include students being too busy, the quizzes not aligning with their learning approaches, or simply forgetting to engage with them. Other factors, such as the perceived difficulty or lack of interest in the quizzes were considered.

Personal Development and Assessment Quality

The semester brought about growth in my own personal knowledge, particularly in question design, feedback, and understanding the nuanced differences between formative assessment, assessment for learning and assessment of learning. A key

takeaway was the necessity of well-designed assessments paired with quality feedback. To enhance the feedback provided, a review of relevant literature and attendance at seminars was planned before the next cycle commenced, aimed at enhancing the quizzes with pedagogically sound and constructive feedback mechanisms.

The next research cycle focused on the following actions:

1. Addressing the identified barriers to quiz participation.
2. Refining quiz content and format.
3. Enriching the educational experience through targeted, meaningful feedback.

By considering the various aspects of quiz engagement, the intention was to foster an environment where quizzes are not only a tool for assessment but also a catalyst for deeper learning and student success.

5.2. Action Research Cycle 2 (ARC2)

Following ARC1, it was essential to implement refinements based on insights gained from the initial cycle to enhance the engagement and effectiveness of the TEFAs in ARC2. The primary goal for ARC2 was to increase quiz participation by addressing the challenges observed in ARC1, particularly around quiz accessibility, feedback immediacy, and student motivation. To achieve this, adjustments were made in the quiz platform and delivery approach, specifically through a partial shift to the Learnosity [3] platform for two of the five quizzes. Learnosity was chosen largely for its broader range of question types which extended well beyond Moodle's eight question options. By offering up to 50 different question formats, a more user-friendly interface and greater flexibility in quiz design, this platform could open up possibilities for a more interactive and engaging quiz experiences. Although additional analytics features were available on the platform, the main advantage for ARC2 was Learnosity's capacity to support a wider variety of question types and more intuitive quiz navigation (see Appendix F: TEFA/Intervention Materials for examples).

The cohort for ARC2 remained the same as ARC1, offering continuity in data analysis and a foundation for measuring the impact of modifications. Additionally, students in ARC2 had prior experience with the quiz-based learning approach, which potentially helped them navigate and engage more effectively in the second cycle. The planning

[3] Learnosity is an educational technology platform that provides assessment and quiz tools designed for digital learning environments.

phase for ARC2 involved revisiting quiz content and structuring quizzes to align more closely with exam-focused chapter summaries, as requested by students. Various communication channels, including in-class reminders, Moodle announcements, and personalised emails, were employed to remind and encourage students to participate in the quizzes regularly.

Data collection for ARC2 involved capturing engagement metrics from both Moodle and Learnosity logs, quiz data, and student feedback gathered through an end-of-semester survey and a focus group. These methods allowed for comprehensive insights into the adjustments' impact and laid the groundwork for planning ARC3. The following sections offer a detailed analysis of the findings generated from this cycle.

Moodle Engagement Logs and Quiz Data

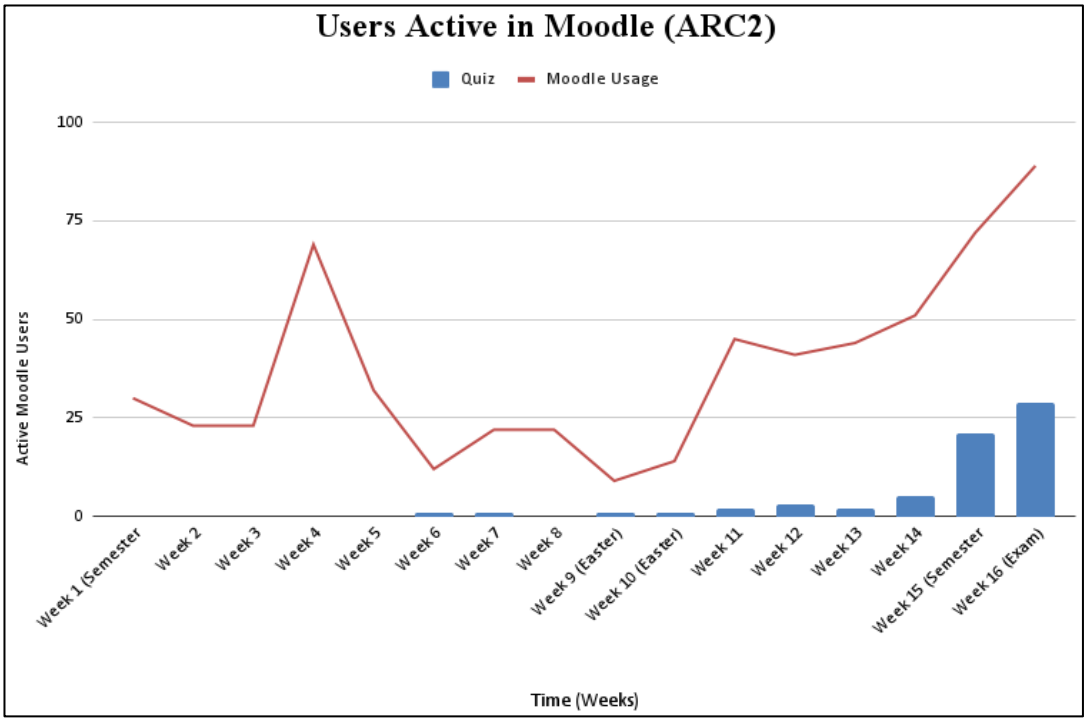


Figure 25. Weekly VLE Engagement Analytics [ARC2]

Figure 25 illustrates weekly Moodle engagement, showing the number of students active on Moodle (red line) alongside those who completed quizzes each week (blue bars) during ARC2. Unlike ARC1, ARC2 exhibits relatively low quiz activity throughout most of the semester, with minimal engagement until the last two weeks, when quiz completions significantly increase. This pattern, consistent with feedback from the ARC2 focus group, suggests that students largely used the quizzes as a revision tool close to the final written examination. The data indicate that while Moodle

remained a resource for general coursework, quizzes were primarily accessed as a targeted study aid in preparation for the final exam.

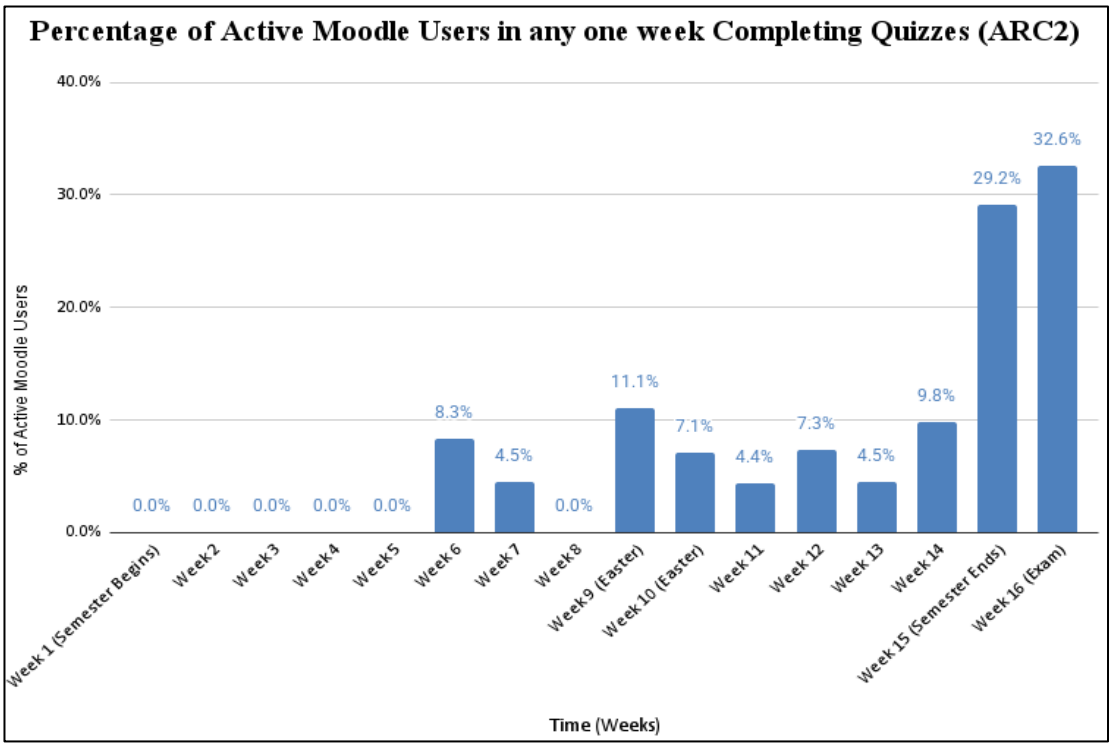


Figure 26. Percentage of Active Moodle Users Completing Quizzes [ARC2]

Figure 26 shows the percentage of active users in any one week who completed a quiz. Unlike ARC1 where there were multiple usage peaks, there was a different usage pattern in ARC2. In ARC2 we see negligible usage of quizzes throughout the semester, with a significant increase in the final two weeks before the final written examination.

It suggests, and is backed up by data from the ARC2 focus group, that students were using the quizzes as a study aide in the run up to the final written examination. The data showed that 30-35% of active Moodle users completed at least one quiz in the final two weeks of study, but in the other weeks less than 11% of active users did so.

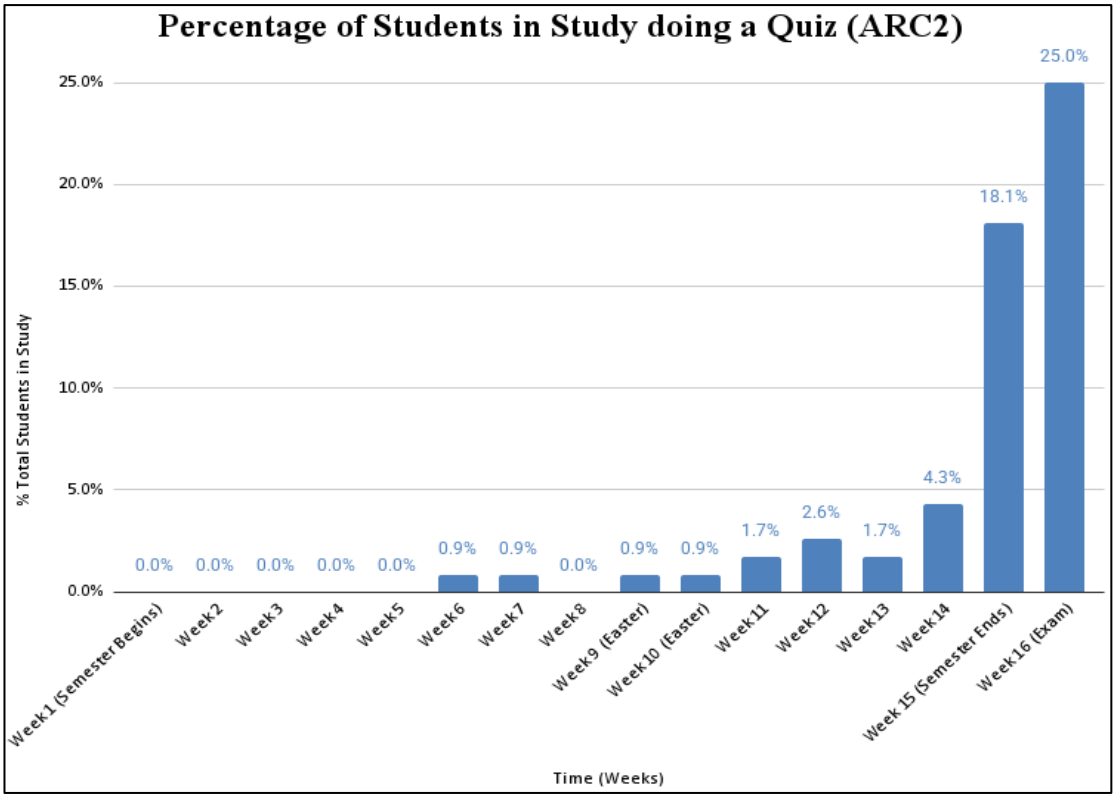


Figure 27. Percentage of Active Moodle Users Engaging with Quizzes [ARC2]

Figure 27 provides a broader view by showing quiz engagement as a percentage of all students in the study, regardless of their weekly activity on Moodle. We see a similar trend, with most of the usage in the final two weeks, however when looking at all students in the study it is clear how infrequently students did quizzes outside of the immediate run up to the final written exam at the end of the semester.

Quiz Data Analysis

Quiz	Attempts	No. of Clickthroughs	No. of Students	Average no. of attempts / student (CTR)	% of students on module	No. of Questions	Date Issued
Quiz 1	49	13	39	1.26	34%	25	Week 6
Quiz 2	49	8	33	1.48	28%	16	Week 10
Quiz 3 (L)	66	1	26	2.54	22%	15	Week 13
Quiz 4 (L)	60	1	21	2.86	18%	11	Week 12
Quiz 5	16	21 6	16	1.00	14%	17	Week 13
Total	267						

Table 4. General Quiz Data [ARC2] (N=116)

Note: Attempts refers to the number of times each quiz was completed. No. of Clickthroughs represents instances where students accessed the quiz page without completing it, while No. of Students indicates the unique number of students who completed each quiz at least once.

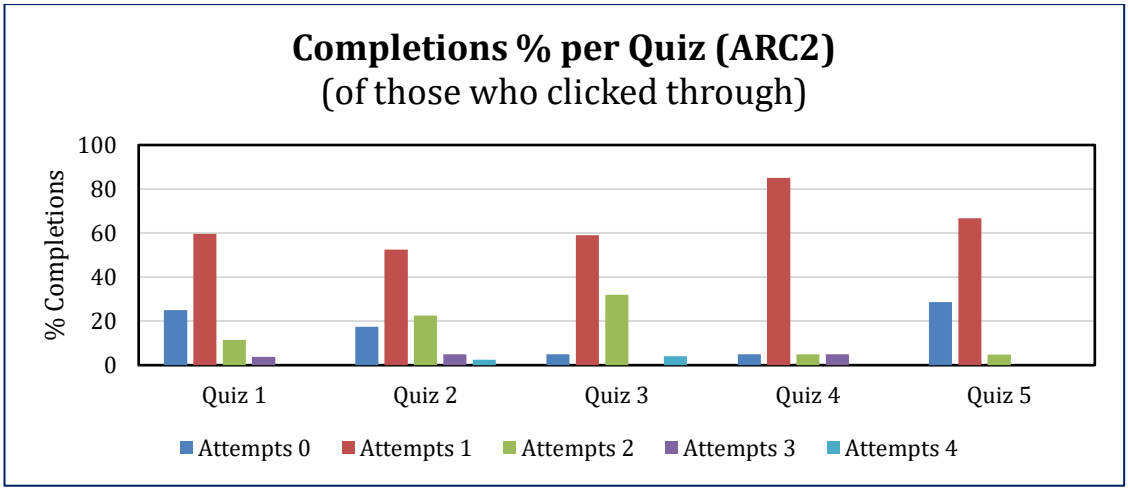


Figure 28. Percentage of Completions per Quiz [ARC2]

This chart shows the percentage of attempts at each quiz based on the learners who clicked on the link and got as far as the start of the quiz. The two Learnosity quizzes (3 and 4) had the highest number of attempts, and each had only one learner who did not attempt the quiz once they arrived. It must be noted that a substantial percentage of students did not click on the quiz links. As shown in the chart below, the percentage of students who did not click ranges from 68% for Quiz 1 to 95% for Quizzes 4 and 5.

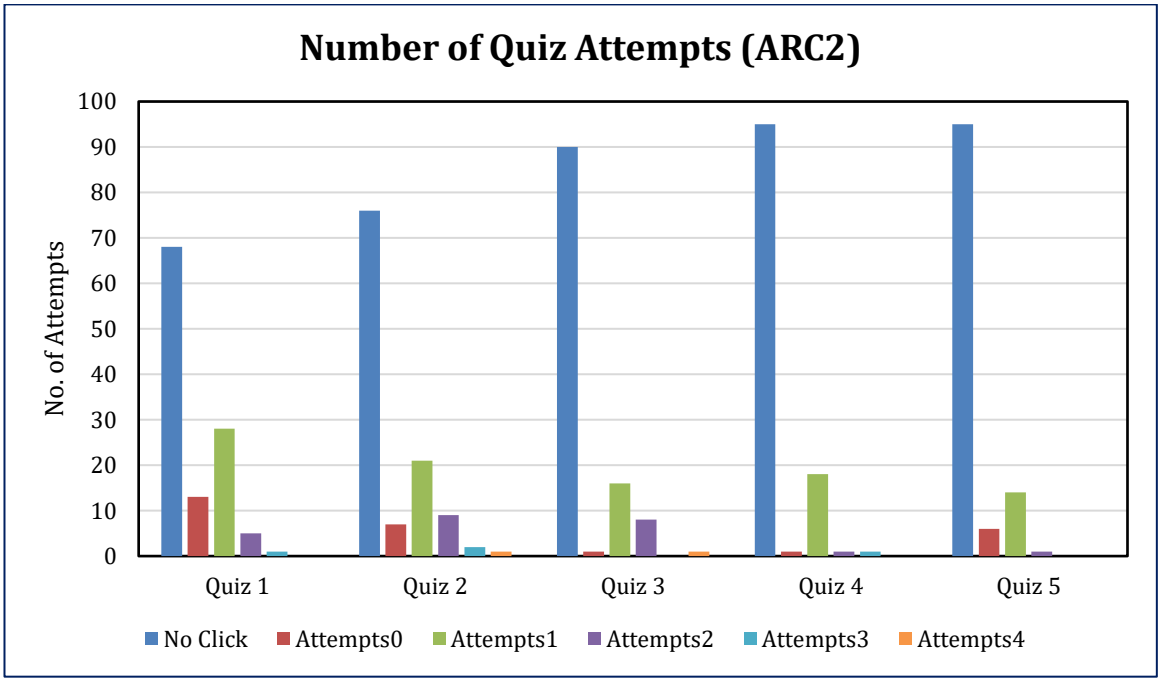


Figure 29. Number of Attempts per Quiz [ARC2]

It is clear from Figure 29 that most learners did not attempt each quiz. That is, the learners either did not even click on the link or clicked on it, got as far as the quiz and did not actually start the quiz or complete any questions. They may have scrolled

through the quiz without answering. The number of learners who did not attempt each quiz increased from the beginning to the end of the semester. As part of the formative assessment process, I was expecting the opposite trend, hoping to see increased engagement with the quizzes as students progressed through the semester. This observation is further reflected in the Theory Exam, where most students focused on the first three topics, potentially indicating limited engagement with the last two topics.

Comparisons with ARC1

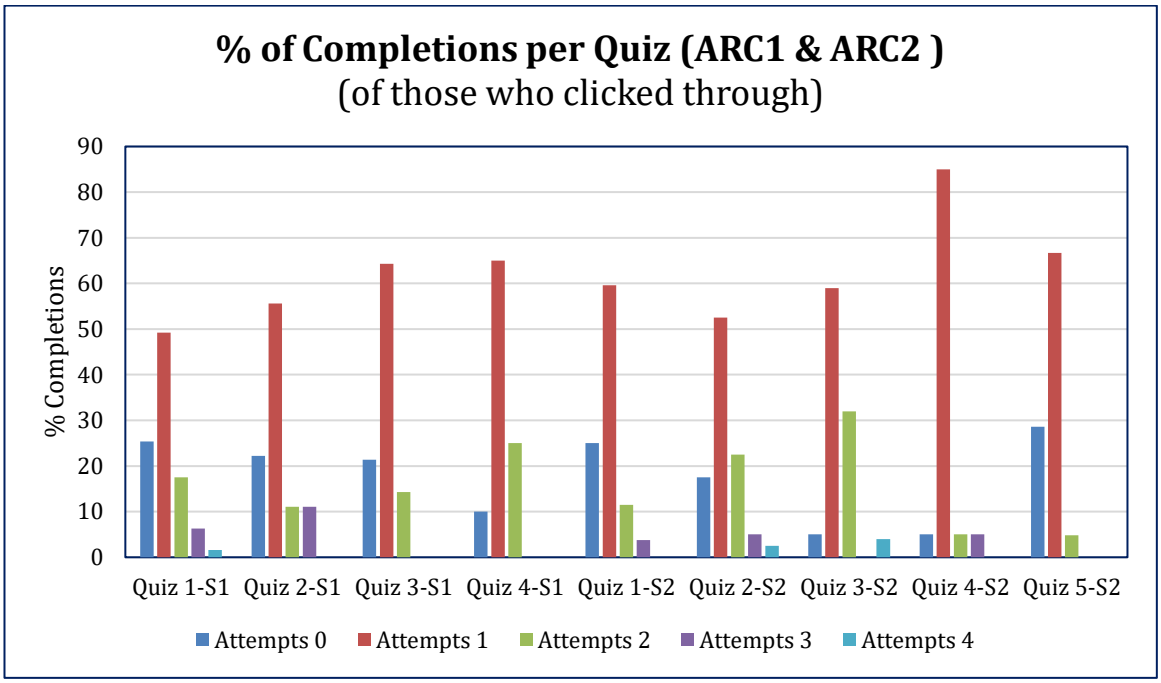


Figure 30. Completions per Quiz [ARC1 & ARC2 combined]

This bar graph presents the percentage of completions per quiz, specifically for those participants who clicked through to attempt the quizzes across both action research cycles (ARC1 and ARC2). There is a consistent pattern where the majority of quiz attempts stopped after the first try (Attempts 1). Quiz 4 in Semester 2 (Quiz 4-S2) exhibits the highest completion rate on the first attempt, while the lowest completion rates after the first attempt are observed in Quiz 3 and Quiz 4 of Semester 1 (Quiz 3-S1 and Quiz 4-S1), where there were no third or fourth attempts. Reattempt rates are generally low across both cycles, but there is a notable uptick in second attempts in Quiz 3-S2.

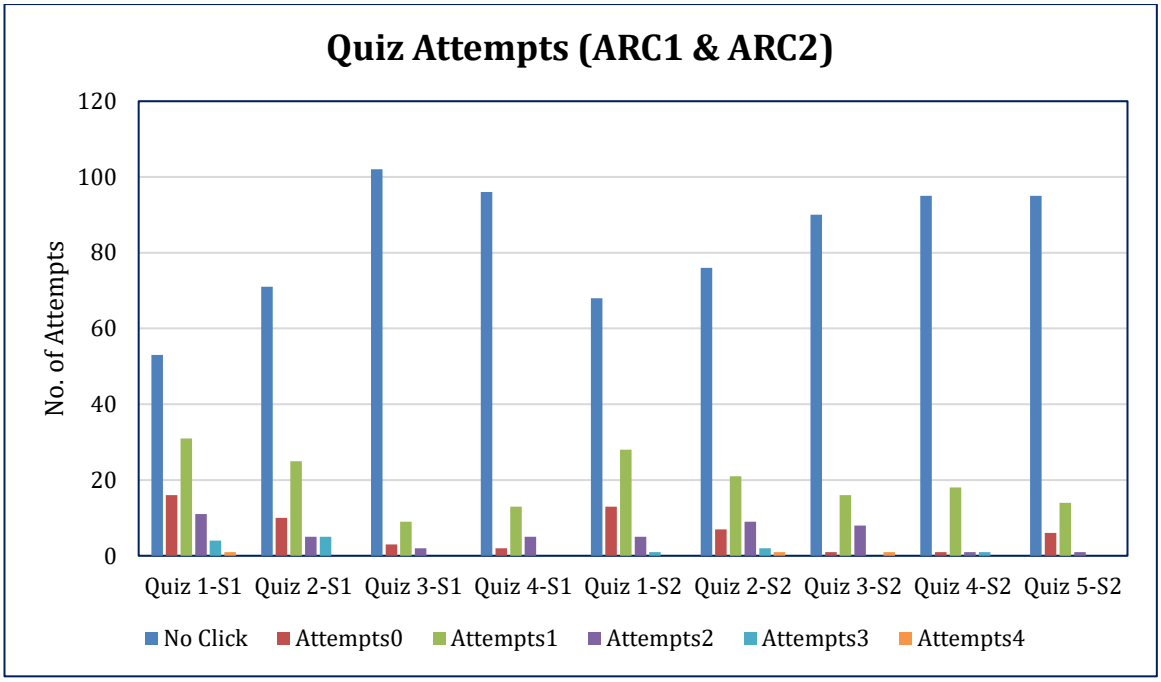


Figure 31. Number. of Attempts per Quiz [ARC1 & ARC2 combined]

This bar graph displays the raw number of quiz attempts across both ARC1 and ARC2. The data show a high number of participants not clicking through to the quiz (No Click) compared to those attempting the quiz at least once (Attempts 0-4). Notably, Quiz 3-S1 and Quiz 4-S1 in ARC1 show an exceptionally high 'No Click' rate, whereas Quiz 4-S2 in ARC2 exhibits the lowest 'No Click' rate. There is a trend of declining reattempts with subsequent quizzes in both ARC1 and ARC2.

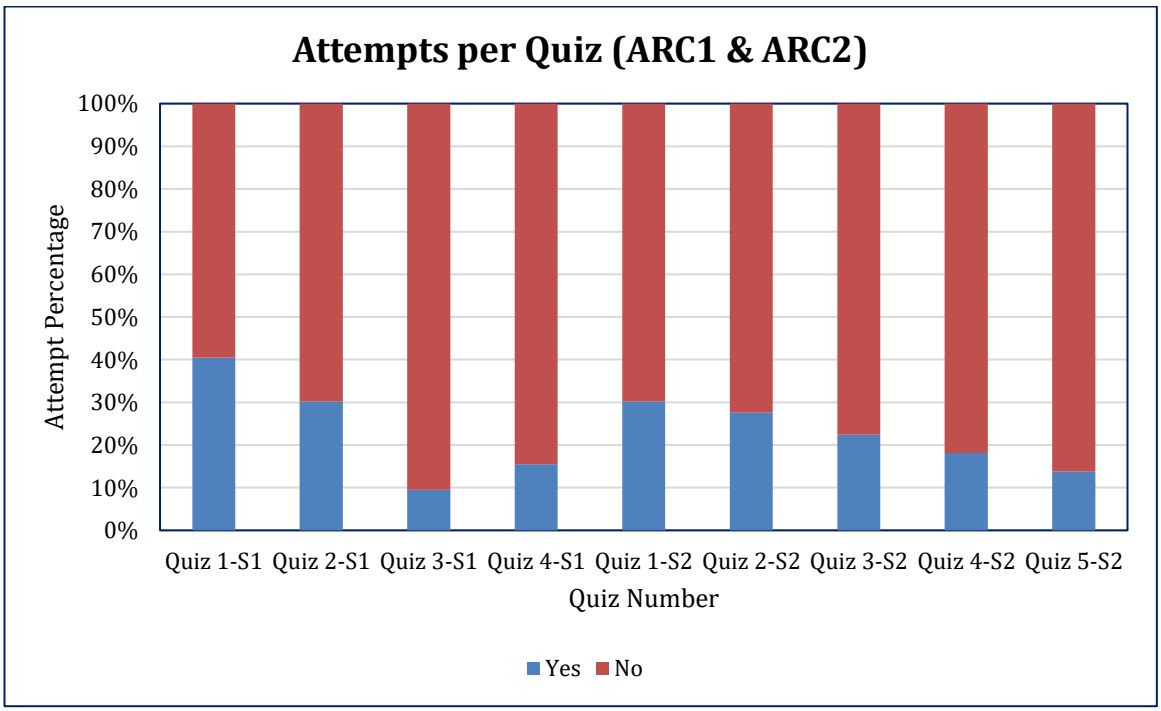


Figure 32. Total Attempts per Quiz [ARC1 & ARC2 combined]

Figure 32 illustrates the proportion of students who attempted each quiz (Yes) against those who did not (No) in both ARC1 and ARC2. The data indicates a general trend where a significant majority did not attempt the quizzes across both cycles. Quiz 1 in Semester 1 of ARC1 (Quiz 1-S1) had the highest percentage of attempts, while Quiz 5 in ARC2 (Quiz 5-S2) had the highest lowest percentage of attempts.

An analysis of quiz engagement over two action research cycles reveals distinct patterns and opportunities for pedagogical refinement. A substantial proportion of students chose not to engage with the quizzes, as seen by the high rates of 'No Clicks' and 'No' attempts. Among those who did engage, a preference for only a single attempt was prevalent, with a marked decrease in students opting for subsequent attempts.

Comparing the engagement between Semester 1 (ARC1) and Semester 2 (ARC2), there is an observable shift. In ARC2, specifically in Quiz 4-S2, there was an improvement in initial engagement, signified by a lower 'No Click' rate and a higher percentage of completions on the first attempt. This trend, however, did not consistently carry through to Quiz 5-S2, which saw a dip in both initial engagement and subsequent attempts.

While the reattempt rates remained low across both semesters, indicating a potential area for further action, the data from ARC2 suggest an overall improvement in engagement with the quizzes. It is highly probable that this improvement in ARC2 can be attributed to the interventions and enhancements informed by the findings from ARC1, as well as the fact that students in ARC2 had the experience of ARC1 to draw on. Despite these gains, the challenge persists in motivating a greater number of students to not only begin but also to continue engaging with the quizzes to deepen their learning experience.

Correlation Data (Attendance, Exam Results, Quiz Attempts)

Due to the lack of engagement in the latter quizzes, comparison with attendance, exam results, and the number of quizzes completed was more difficult. Therefore, for this analysis, the number of clicks was considered, that is, if a student clicked and looked at a quiz, it was counted, even if they did not submit it. This approach was taken because clicking on the quiz still indicated some level of interaction and potential engagement with the content, even if the quiz was not completed.

Variable	1	2	3	4
1 # of Clicks on Quizzes	1			
2 Attendance	.172	1		
3 Theory Grade	.276*	.137	1	
4 Overall Grade	.258*	.353*	.745**	1

Table 5. Correlations: Quiz Attempts, Attendance and Academic Performance [ARC2]
*Note: * correlation significant at 0.05 level, ** correlation significant at 0.01 level. N=115.*

A Spearman's correlation was conducted to examine the relationships between the number of clicks on quizzes, attendance, theory grades, and overall grades. As shown in Table 5, it revealed several statistically significant correlations. There was a significant positive correlation between the number of clicks on quizzes and theory grade, r_s (113)=.276, p=.003. Similarly, there was a significant positive correlation between the number of clicks on quizzes and overall grade, r_s (113)=.258, p=.005. This indicates that there is a small relationship between quiz engagement and grades. There was also a significant correlation between attendance and overall grade, r_s (113)=.353, p<.001, those who attended more classes tended to achieve higher grades. However, all three correlations are weak correlations.

End of Semester Survey

The end-of-semester survey for Action Research Cycle 2 garnered responses from 29 out of the 116 enrolled students, yielding a response rate of approximately 25%. The lower response rate may reflect factors such as students' perceived workload, survey fatigue from previous cycles, or competing academic demands near semester's end. Additionally, students may not have felt strongly about the quizzes, as participation data showed varying levels of engagement. These insights suggest the importance of timing and perceived relevance in future survey efforts to encourage broader participation.

Of the 29 respondents, 83% (24 students) reported completing at least one quiz during the semester, while the remaining 17% (5 students) did not attempt any quizzes. Non-participants frequently cited reasons such as feeling too busy, adhering to established study routines, or finding the substantial theoretical content of the module sufficient for their needs. This feedback was used to inform potential adjustments to quiz implementation in future cycles to enhance relevance and accessibility for a wider range of students.

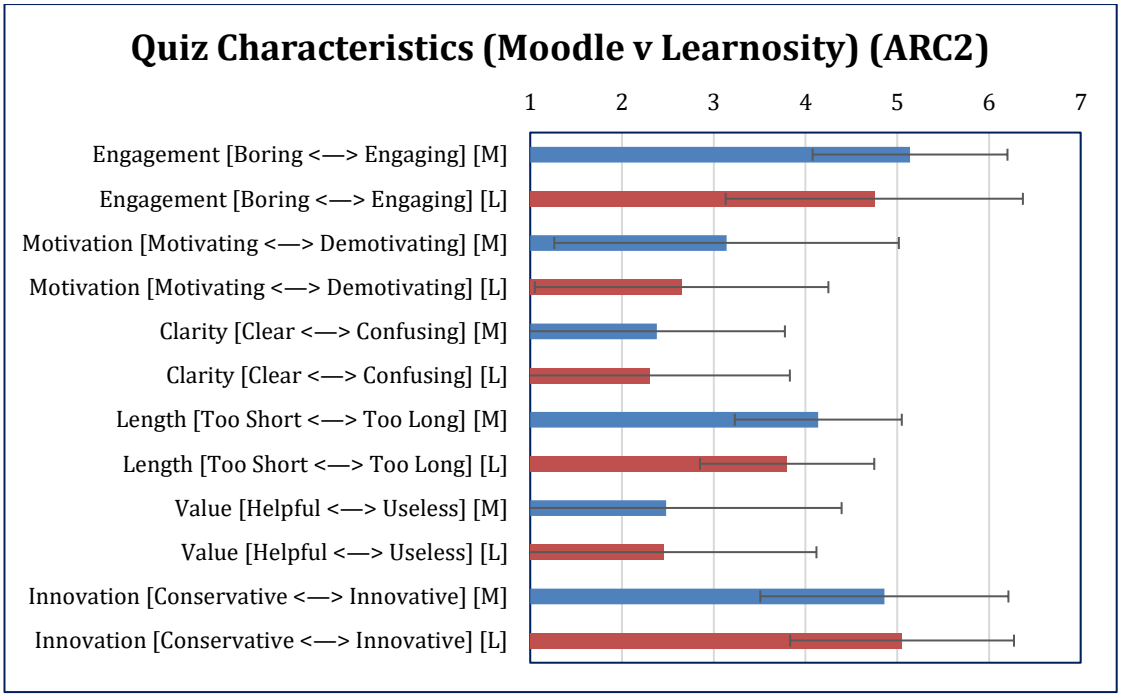


Figure 33. Quiz Characteristics (Moodle v Learnosity) [ARC2 End of Semester Survey]
Note: Scores indicate averages on a 7-point Likert-type scale. Error bars indicate ±1 SD
** [M] denotes Moodle Platform, [L] denotes Learnosity Platform*

In this ARC2 end-of-semester survey, students once again evaluated eight quiz characteristics for both Moodle and Learnosity using the same 7-point Likert-type scale as in ARC1, allowing for a direct comparison across platforms.

Moodle had an average engagement rating of 5.14 (SD = 1.06), with 81% of students describing the quizzes as engaging. That is a significant increase from 42% at the end of ARC1 (see Figure 23), suggesting that changes made between cycles substantially improved students' perceptions of Moodle quizzes. Meanwhile, Learnosity's engagement average was 4.75 (SD = 1.62), with 70% of students finding those quizzes engaging.

Motivation followed a different pattern. Moodle's motivation average was 3.14 (SD = 1.88), with 62% of respondents feeling motivated. By contrast, Learnosity's average of 2.65 (SD = 1.60) corresponded to 75% of respondents being motivated after taking a quiz, indicating that Learnosity may more consistently support students' motivation levels, although Moodle may have had some highly enthusiastic users.

In terms of clarity, Moodle scored 2.38 (SD = 1.40), with 76% of students considering the quizzes clear, compared to 71% at the end of ARC1. Learnosity scored 2.30 (SD = 1.53), with 80% reporting clarity. Both results suggest a noticeable improvement from ARC1, reflecting enhanced quiz design and instructions.

The average response to the question about whether they thought the quizzes were too long or too short were 4.14 (SD = 0.91) for Moodle and 3.80 (SD = 0.95) for Learnosity, with many students selecting a neutral response. This marks a shift from ARC1, when a majority found the quizzes too long. While differences remain, these results indicate that quiz length may have become more manageable during ARC2.

Value (helpful vs. useless) remained high for both platforms: Moodle's rating was 2.48 (SD = 1.91), with 76% finding the platform helpful, while Learnosity's rating was 2.45 (SD = 1.67), with 80% finding the new platform helpful. These figures echo ARC1 results, in which 77% of students found the quizzes valuable.

Innovation was one area where Learnosity had a slight advantage. Moodle's innovation rating was 4.86 (SD = 1.35), with 52% viewing it as innovative, whereas Learnosity's rating was 5.05 (SD = 1.22), with 63% perceiving it as innovative. These numbers exceeded ARC1's previous outcomes, indicating that the iterative design updates had further enhanced students' sense of novelty and creativity.

Overall, Moodle showed a marked increase in engagement since ARC1, while Learnosity scored well in motivating students and appeared to the students to be somewhat more innovative. Both platforms registered high clarity and value ratings, indicating that the changes made after ARC1 effectively addressed earlier concerns about quiz design and instructions. The data also indicated that students found quiz length more manageable in ARC2 than in previous cycles, suggesting that modifications to content volume and pacing were successful. Meanwhile, the higher standard deviations seen in some categories, particularly Learnosity's engagement, suggested that individual experiences still varied considerably. Comparing these outcomes to both mid-semester and end-of-semester results from ARC1, it was clear that overall student perceptions had shifted in a positive direction for both platforms.

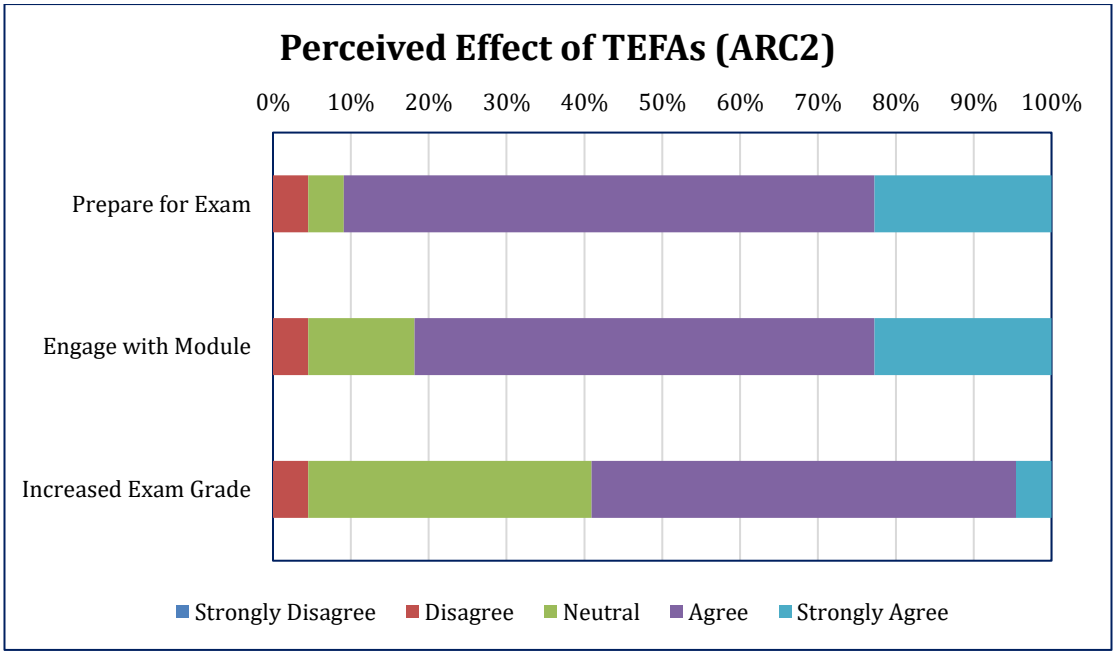


Figure 34. Perceived Effect of TEFAs on Exam Preparation, Engagement, and Grades [ARC2 End of Semester Survey]

The survey also sought to evaluate the impact of TEFAs on students' preparation for exams, engagement with module material, and actual exam grades. The results provide a compelling narrative of the perceived effectiveness of the TEFAs.

Regarding exam preparation, only 5% of respondents expressed disagreement that the TEFAs helped them prepare for the exam, while a substantial 91% concurred that the TEFAs were helpful, with 75% agreeing (15 respondents) and 16% strongly agreeing (5 respondents). The remaining 4% held a neutral position, indicating neither agreement nor disagreement. This overwhelming consensus clearly shows the TEFAs' role as a beneficial tool in exam preparation.

When examining engagement with the module material, again, only 5% disagreed with the assertion that TEFAs enhanced engagement. A significant 82% affirmed their agreement, split between agree (13 respondents) and strongly agree (5 respondents), and a small 14% remained neutral. This indicates that TEFAs are largely perceived as an effective means to deepen engagement with the learning content.

The influence of TEFAs on improving exam grades showed a more diverse set of responses. While 5% disagreed, a majority of 59% either agreed (12 respondents) or strongly agreed (1 respondent) that their exam grades increased as a result of completing the TEFAs. Nevertheless, 36% of participants withheld a definitive stance, remaining neutral on the subject.

These findings reflect a general positive perception of TEFAs in supporting exam preparation and module engagement, with a more varied view on their direct impact on exam grades. The high percentage of neutrality on grade improvement suggests that while many students saw a link between TEFAs and academic performance, there was still a portion of the cohort that was uncertain or yet to be convinced of this correlation.

Comparison with ARC1 Survey

Comparing the results from the end of Semester 1 to the end of Semester 2 revealed some shifts in student perceptions regarding the quizzes. In the context of exam preparation, ARC2 results showed an increase in positive reception, with 91% agreeing or strongly agreeing that quizzes helped in preparing for exams, up from 56% in ARC1 (see Figure 24). Disagreement in Semester 2 was at a low 5%, a notable decrease from the 24% in ARC1, indicating a more widespread acceptance of the quizzes as a valuable study aid.

Engagement with module material also saw a positive change, with 82% in agreement in ARC2, compared to 58% in the previous semester. Moreover, the disagreement decreased to 5% from 13%, and neutrality also saw a slight decrease. This suggests that the quizzes were better received in terms of fostering engagement with the course content in the subsequent semester.

The perceived impact of quizzes on exam grades saw an improvement, albeit less pronounced. In ARC2, 59% agreed or strongly agreed that quizzes increased exam grades, compared to a balanced 30% agreement in ARC1. The neutral responses decreased to 36% from 40%, showing that fewer students were undecided about the quizzes' effect on their grades.

In summary, the end of ARC2 survey results indicated a more favourable student perception of the quizzes across all three areas measured. It is probable that the enhancements or changes made to the quizzes between the semesters contributed to these improved perceptions, suggesting that the iterative refinements based on prior feedback were effective in enhancing the educational value of the quizzes.

Responses to the Open-Ended Survey Questions

Like ARC1, this survey included four open-ended questions aimed at understanding students' engagement with the quizzes and identifying areas for improvement. The questions asked were: "*If you did not attempt a quiz this Semester, can you outline the main reason(s) why you did not?*" with 3 responses, "*Any comments on the Moodle*

quizzes?" with 5 responses, "*Any comments on the Learnosity quizzes?*" with 10 responses, and "*What features of the quizzes did you find most helpful"?* and an invitation to add other comments with 3 responses. The feedback highlighted broader themes related to time management and prioritisation, user experience and accessibility, quiz design and effectiveness, and motivation and engagement.

1. Time Management and Prioritisation

A significant challenge for students who did not engage with the quizzes was managing their time amidst various academic duties. Many expressed sentiments such as "*Too busy studying plus prefer to use my own method for revision*," and "*I was too busy trying to keep on top of CA and assignments and just hadn't time.*" These comments reflect a tendency for students to prioritise activities they perceived would that directly contribute to their final grade, such as continuous assessments (CA) and assignments. The fact that quizzes were not assigned a percentage of the overall grade likely influenced this decision. Students said they generally focused on tasks that contributed to their overall grades.

Additionally, the volume of content in the module added to the pressure they said they were under, with one student noting, *"There was too much content in the module overall, it really needs to be more focused."* This suggests a need for a more streamlined approach to module content, as well as consideration of assigning a percentage of the grade to quizzes to encourage engagement. The idea of incentivising quiz participation through grade allocation also emerged as a key theme during the End of Semester Focus Group, where participants debated the effectiveness of offering marks to increase engagement.

2. User Experience and Accessibility

Technological accessibility and familiarity with digital platforms were critical factors in students' engagement with the quizzes. Many students expressed a preference for Moodle due to their familiarity with the platform. One student stated, "*I preferred the Moodle quizzes to Learnosity as I was more familiar with them from the first semester.*" This comfort derived from previous use suggests that consistent use of a single platform can lead to increased engagement. However, the Learnosity platform, while found helpful by some, received feedback for needing more comprehensive quizzes, with one student saying, "*I would have liked a few more questions in this quiz."* The ability to retake quizzes was seen as beneficial for reinforcing their learning and preparing for

assessments, highlighting the value of iterative learning processes. Summing this up one student stated, *"Being able to do the quizzes multiple times was great in order to prepare for the CA and then the final exam!"*

3. Quiz Design and Effectiveness

The design and structure of the quizzes significantly influenced student engagement. Students acknowledged the quizzes were a refreshing change from traditional study methods, with one commenting, "*It was a nice change to re-reading note power points or textbook chapters.*" The role of quizzes in summarising chapters and providing a structured revision path was appreciated, indicating their potential to enhance study efficiency. However, once again in the findings, there was a clear preference for shorter quizzes, with feedback such as, "*Make the length of the quizzes shorter,*" reflecting the need for quizzes that are concise and relevant.

Referencing the Learnosity quiz, one student also mentioned that "*The chapter 12 form of quiz is more engaging,*" highlighting the importance of engaging content to improve retention. This may be attributed to the enhanced functionality and interactive features of the Learnosity platform, which provided a more dynamic learning experience compared to the Moodle quizzes. The positive response to this quiz in this and other comments suggested that advanced interactive elements could further improve engagement and retention across other quizzes.

4. Motivation and Engagement

Students' motivation to attempt a quiz and their perception of the quizzes' relevance were connected factors in determining their participation in the TEFAs. A lack of interest in the module content or simply forgetting about the quizzes were common reasons for non-participation. One student admitted, "*I forgot about them,*" while another noted, "*The topics are not interesting for me.*" This indicated that the quizzes were not always prioritised in students' study routines. However, when students found the quizzes engaging and well-designed, they credited them with improving their focus on specific learning outcomes or exam-related content. One student found that the quizzes helped in "*highlighting what I didn't know and helps me look at things in the specific rather than the general.*"

The survey responses revealed that while quizzes are a valued revision tool, there was still room for improvement in their design, scheduling, and integration into students' established study routines. To maximise their impact, quizzes must consider students'

time pressures, align with their learning preferences, manage content volume effectively, maintain platform consistency, and enhance engagement with targeted learning outcomes.

Comparison with ARC1

The similarities between ARC1 and ARC2 indicated that students across different semesters faced consistent challenges related to time management, user experience, quiz design, and motivation. Both sets of responses suggested a need for quizzes to be integrated more seamlessly into students' study routines, with consideration for time constraints and learning preferences. Differences were minimal, mainly reflecting the specific platforms used (Moodle vs. Learnosity) and the slight variations in feedback on quiz length and engagement. Overall, these insights informed improvements in the design and implementation of quizzes to better support student engagement and learning outcomes.

When comparing the feedback from the end-of-semester surveys in ARC1 and ARC2, several notable similarities and differences emerged. In both ARC1 and ARC2, time constraints and academic prioritisation were significant factors affecting students' engagement with quizzes. Students in both surveys expressed that their demanding academic schedules made it difficult to find time for quizzes. This highlighted a common challenge across both groups in balancing quizzes with other academic responsibilities.

Technological accessibility and familiarity with digital platforms were also crucial factors highlighted in both ARC1 and ARC2. Students in ARC1 mentioned difficulty in adapting to online study methods and issues with accessing the quizzes. Similarly, ARC2 students expressed a preference for Moodle due to familiarity. This suggested that students' comfort with a particular platform significantly influenced their engagement.

Students from both surveys valued well-designed quizzes but preferred them to be concise and relevant. Responses from ARC1 included appreciation for clear and informative quizzes, along with requests for shorter quizzes. ARC2 students echoed these sentiments, appreciating the quizzes as a change from traditional study methods but also highlighting a preference for shorter quizzes. This consistency indicated a need for quizzes that are both engaging and manageable within students' study schedules.

Motivation and perceived relevance were pivotal in both surveys. In ARC1, students' lack of interest or forgetting about the quizzes were common themes, and similar sentiments were echoed in ARC2. Additionally, ARC1 included suggestions for making quizzes more engaging through gamification or rewards, a strategy that could also benefit ARC2 students.

End of Semester Focus Group

Following on from the open-ended responses, the analysis of the ARC2 focus group provided a richer understanding of student perceptions and use of quizzes in their learning. The discussion covered various aspects of quiz engagement, the strategic approaches students adopt in using quizzes to guide their study efforts, the design and content of quizzes and their influence on learning, and the role of feedback in shaping learning outcomes and study behaviours. Additionally, the analysis describes the participants' suggestions for enhancing the effectiveness of quizzes. They offered a wide range of insights into potential improvements in the design, implementation, and integration of the TEFAs into the curriculum.

1. Differences in Engagement with Quizzes

Quiz use among the focus group participants varied considerably, ranging from comprehensive engagement to selective or minimal interaction. FG2Speaker8 reported, "*I did all five of them this semester and all four of them last semester*," indicating high engagement. FG2Speaker7 mentioned, "*I did one or two, but they were helpful,*" reflecting moderate engagement. FG2Speaker6 stated, "*I think I did one only,*" showing limited engagement, while FG2Speaker5 admitted, "*I didn't do any of them,*" indicating no engagement.

This variation here pointed out the diverse roles quizzes played in supporting learning and the different strategies students adopted in their studies. For instance, FG2Speaker1's thorough engagement with all available quizzes, "*all of them,*" suggested a proactive approach, using quizzes as fundamental study tools. This strategy implied a recognition of the value of quizzes beyond mere assessment. In contrast, FG2Speaker5's minimal engagement, driven by a perceived lack of relevance or immediate benefit, "*I looked at one of the quizzes...and thought I had better things to do,*" highlighted the importance of clearly communicating the quizzes' intended value and impact on learning outcomes to students. This disparity in engagement levels suggested a need to align quiz content and design with students' expectations and

learning objectives. This would ensure quizzes were seen as beneficial and relevant to their academic success. FG2Speaker4's selective engagement with quizzes specifically related to their chosen exam topics, "*I only did the quizzes pertaining to the exam I was going to do,*" reflected a strategic use of quizzes to reinforce learning in areas deemed most critical by the student. This method illustrated the role of quizzes in facilitating targeted study and revision, allowing students to allocate their study time more efficiently by focusing on areas of perceived weakness or high importance.

2. Strategic Utilisation of Quizzes for Focused Studying

Linked to the point above, the focus group highlighted the strategic use of quizzes as tools for targeted studying among participants. It revealed the various ways they employed quizzes to identify study gaps, focus on specific topics, and solidify understanding. FG2Speaker1 noted, "*I did the quizzes before I did any study. Then how I did in the quizzes helped me decide what topics to study further,*" illustrating a proactive strategy. Similarly, FG2Speaker3 said, "*Knowing those topics, I did the quizzes before any study. As a result, they were difficult, but if I got a reasonable mark I would continue with that topic. If I did terrible, I might reconsider my choice of topic,*" highlighting the use of quizzes to assess initial understanding and guide further study.

Participants also used quizzes for focused preparation on chosen topics. FG2Speaker4 explained, *"So, of the three topics, I did quizzes pertaining to those.... But for the summer exam, I decided what topics I was going to study. I never looked at the others because I was thinking that's going to do those topics. I had to manage my time."* FG2Speaker6 added, *"It was on a topic I had decided I was going to do for the exam,"* demonstrating a selective approach to quiz engagement based on exam relevance.

Quizzes were also valued for enhancing understanding and knowledge retention. FG2Speaker8 remarked, *"The quizzes were really, really helpful ... and it gives you more insight and understanding of what is being taught in class, which I think is great,"* and further noted, *"But when you are outside of class and reading the quiz, you are more informed and you get what has been taught more. And you get a better understanding of what is being taught in class."*

Additionally, participants had specific preferences and motivations regarding quiz formats and resources. The comment by FG2Speaker5 showed appreciation, "*The yes/no answers were great. And good for study.*" FG2Speaker8 mentioned, "*If you could attempt it again and the second time you did very good and then you get a better grade*

overall and are more motivated," and valued the comprehensiveness of resources, stating, "*The chapter summary, the quizzes on the chapter summary and the feedback were all very helpful.*"

These varied approaches showcased individualised learning strategies. FG2Speaker1's method of using quizzes to pinpoint study topics, "*I did the quizzes before I did any study ... They followed on from each other ... You could expand on this later,*" highlighted the strategic use of quizzes as diagnostic tools, identifying strengths and weaknesses before in-depth study. Similarly, FG2Speaker3's approach, "*I started the quizzes before I did any study ... if I got a reasonable mark I would continue with that topic,*" exemplified using quizzes for preliminary assessment. FG2Speaker4's selective engagement with quizzes was based on predetermined exam topics, "*So of the three topics, I did quizzes pertaining to those,*" which highlighted a focused strategy, concentrating study efforts on critical exam areas and reinforcing chosen study paths rather than guiding initial topic selection.

3. Preference for Concise, Engaging Quizzes with Clear Feedback

Participants' preferences for specific quiz characteristics varied, including length, difficulty, question type, and feedback. Most participants preferred quizzes of moderate length, as FG2Speaker1 noted, "*Anything that was over 30 minutes I would lose interest in and not do.*" FG2Speaker4 agreed, stating, "*Not too long or too short. If you study, it was easy enough,*" but added that longer tests, such as those with 40 questions, could become boring. FG2Speaker8 found the quizzes very long in semester 1, describing them as "*really very boring and tiring sometimes.*" However, some participants, like FG2Speaker3, found the length acceptable, viewing study as work: "*Length was ok. Interesting or not? Study is work.*" FG2Speaker8 also acknowledged benefits from the longer quizzes, despite their length.

Regarding difficulty, participants generally preferred quizzes of moderate difficulty. FG2Speaker8 said, "*They were not too easy. They were just informative and educative,*" and FG2Speaker6 added, "*Not too hard.*" Some participants appreciated a challenge, as FG2Speaker8 noted, "*what I can say is that the last one was really perfect,*" referring to a potentially more challenging quiz.

Participants expressed preferences for concise question formats, with FG2Speaker1 stating, "*I liked the short questions. MCQ,*" and FG2Speaker8 highlighting, "*The last quiz was very good. Because you have to fill in the gaps.*" Open-ended questions were

also valued when accompanied by clear feedback. FG2Speaker8 preferred quizzes where "*you typed in a longer theory answer or even a short answer or a word,*" but FG2Speaker1 found that "*No prescribed answer for open-ended questions, even with feedback, was not ideal.*"

The focus group also revealed a preference for engaging and interactive quizzes, with FG2Speaker8 appreciating the "*drag and drop [Learnosity] one,*" finding it "*just really interesting.*" Feedback was seen as valuable, particularly for objective questions. FG2Speaker1 noted, "*For objective questions, getting it wrong and being given the correct answer was almost more beneficial than getting it right.*" However, clarity and accuracy in feedback were crucial, as FG2Speaker1 pointed out a frustration with question design: "*There was one question where I answered 'MIS' and got it wrong. The correct answer was 'Management Information Systems' which of course is the same thing.*"

These responses highlighted key aspects of quiz design that influence student participation and educational value, including quiz length, question format, content relevance, and alignment with course objectives and exam expectations. FG2Speaker1's feedback on quiz length emphasised the need for a balance between offering sufficient content and maintaining engagement. FG2Speaker4 echoed this, suggesting that excessive length could diminish focus and interest. Question design played a crucial role, as illustrated by FG2Speaker1's frustration with unclear answer formats and FG2Speaker8's appreciation of diverse question types.

The importance of aligning quiz content with the course content was highlighted by participants like FG2Speaker3, who used quizzes to decide study topics. This alignment supported the role of quizzes in guiding study priorities and reinforcing learning in key areas. The provision of immediate and specific feedback was identified as valuable, with FG2Speaker1 noting the benefit of being corrected, which clarified misunderstandings and contributes to deeper learning.

4. Varied Engagement with Feedback and Its Impact on Learning

Diverse approaches to feedback use and its impact on learning were revealed. FG2Speaker1 admitted, "*I didn't spend time reviewing the feedback after the fact,*" and FG2Speaker3 echoed this, saying, "*Once I did the quiz, I never went back in. I ignored the feedback.*" FG2Speaker8 noted that classmates "*never opened it up again.*" In contrast, some participants engaged selectively with feedback. FG2Speaker1 found that,

"W*hen I got something wrong, it showed me where I got it wrong. This was the advantage of objective questions over subjective/open-ended questions.*" FG2Speaker7 stated, "*When I didn't know the answers, I would write it down as a topic to study,*" and FG2Speaker8 mentioned, "*I checked back a few times and there was no answer there afterwards. But I don't mind checking back so I went back in actually ...*"

Participants perceived several benefits from feedback. FG2Speaker1 noted, *"Objective questions were better for study - right and wrong answers helped me study."* FG2Speaker6 added, *"When I got it wrong I would take note of the correct answer and write it down. Then I would remember the right answer."* FG2Speaker8 found it *"very helpful getting the right answer because sometimes I don't know the answer. So that's informing and I know what it's supposed to be and what I need to do straight away."* Additionally, FG2Speaker8 noted, *"If you do it one time, then you will look at your feedback. And then you can do it again. And now do good."* These comments suggested a learning strategy focused on how to use feedback to improve performance and direct study efforts, contrasting with more selective decisions about what content to focus on or leave out.

However, challenges with feedback were also highlighted. FG2Speaker1 pointed out that *"the feedback would say for example 'read section 3.2 in the book'. But it was unclear to me where exactly the feedback was referring to, it was not specific enough."* FG2Speaker8 mentioned, *"The waiting one, you know the one you have to wait for the answer, some people don't like the waiting one."* These issues of clarity and timeliness might hinder effective feedback utilisation.

FG2Speaker1's experience illustrated the role of TEFAs in directing study efforts more effectively, noting that feedback needs clarity and directness to guide students toward relevant study materials or concepts. The value of immediate, correct feedback was highlighted by several participants. FG2Speaker1 found significant benefit in being corrected, stating, "*For objective questions, getting it wrong and being given the correct answer was almost more beneficial than getting it right.*" FG2Speaker3 mentioned the benefit of having PDF exports of open-ended sample answers for study purposes, indicating a desire for comprehensive feedback that would extend learning beyond the quiz itself.

FG2Speaker8's comments about the benefits of immediate feedback for reinforcing correct answers and understanding emphasised the motivational aspect of feedback,

enhancing students' confidence and encouraging continued engagement with the learning material.

5. Calls for Clearer Feedback, More Diverse Question Types, and Focus on Exam Relevancy

Several suggestions for improvement emerged, including the need for clearer feedback, more diverse question types, and a focus on exam relevance. FG2Speaker1 emphasised the necessity of feedback clarity, noting that "*feedback ... not specific enough*" was an issue. FG2Speaker7 called for quicker responses with subjective questions, and FG2Speaker3 suggested, "*Would be good to have PDF export of the open-ended sample answers for later help with studying.*" FG2Speaker8 added that quicker feedback would improve the quizzes overall.

Participants also expressed a desire for a wider range of question types. FG2Speaker8 mentioned the need for "*more question types and structured like that last quiz.*" There was a call for alignment with exam formats, as FG2Speaker2 and FG2Speaker6 noted, "*The subjective (open-ended) questions - I could see why they were there. But the exam is essay style/open-ended.*" FG2Speaker5 pointed out that too much content was covered in a semester and suggested focusing on essential information both in the curriculum and quizzes. FG2Speaker8 recommended making quizzes shorter, with "*maybe 10 questions or a maximum of 15.*"

A recurring theme was the need for more specific and actionable feedback. FG2Speaker1's critique of feedback as "*not specific enough,*" highlighted the necessity for feedback that would provide clear guidance on where students could find information to address their knowledge gaps or misunderstandings.

Participants expressed frustration with certain aspects of question design, such as the strictness of answer formats and the clarity of open-ended questions. FG2Speaker1's experience with an answer being marked wrong due to format, as mentioned above, highlighted the need for flexibility in recognising equivalent responses. either for flexibility in recognising equivalent responses or for clear instructions, such as specifying that acronyms should not be used in answers. Additionally, incorporating diverse question types to accommodate varying learning approaches preferences was also appreciated.

Suggestions for improving the coverage and focus of quiz content also emerged. Participants like FG2Speaker5 advocated for a more targeted approach to content,

suggesting that quizzes should highlight the most critical topics. However, it remained unclear what exactly participants meant by *"most critical topics."* They are likely to have been referring to topics directly relevant to exams or likely to appear in exam questions rather than say, important topics for them to know for their future employment. This ambiguity highlighted the need for further clarification in future feedback collection.

Enhancing the technological platform for quizzes to ensure accessibility across devices and stability during completion could address concerns raised by participants like FG2Speaker7, who experienced technical issues. Some participants also suggested that optimising quizzes for completion on various devices, including mobile phones, would improve accessibility and convenience. They felt this would encourage broader participation among their classmates. However, as noted in ARC1 findings, students reported that using smartphones increased the likelihood of distractions, which negatively affected their focus during quizzes. This feedback highlighted the need to balance accessibility with usability, particularly when designing quizzes for mobile devices. Similar concerns about device-related distractions were reiterated in ARC2, reinforcing the importance of a carefully considered approach to mobile-friendly quiz design.

6. Divided Opinions on Incentivising Quiz Engagement

There were a variety of perspectives on incentivising quiz engagement. Those in favour emphasised the importance of contributing to grades. FG2Speaker3 stated, "*I think it should count towards my continuous assessment,*" while FG2Speaker5 echoed this sentiment with multiple mentions of making quizzes part of the continuous assessment grade. FG2Speaker5 also referenced another course that allocated 15% of the final mark for a quiz, suggesting this approach could increase engagement. This belief was supported by FG2Speaker5, who said, "*If there was an incentive, say it was worth 5% of my mark, I might have engaged more,*" and FG2Speaker8, who suggested allocating some marks to encourage participation.

Opponents of incentives questioned their effectiveness. FG2Speaker2 remarked, "*People are not going to do it for nothing. However, the same people that won't do it, won't do it for 5%.*" FG2Speaker7 argued against incentives, stating, "*It's a very useful tool in studying. There should be no need for incentives.*" FG2Speaker8 expressed

concern about inflating grades and diminishing the intrinsic value of studying, noting, *"... that would be 5% overall. Yeah, that's a lot. And it is benefitting you studying too.*"

Additional considerations included supervisory concerns, with FG2Speaker6 stating, "*It would have to be supervised.*" Alternative suggestions were also offered, such as FG2Speaker1's proposal to "*do them as a written test in class*" to promote focus and discourage dishonesty, and the idea of informing students about quizzes on the first day of each topic to encourage early engagement.

The majority of responses indicated a clear consensus on the importance of integrating quizzes with the grading scheme to motivate engagement. For instance, FG2Speaker1 suggested practical approaches to incentivisation, advocating for quizzes to be "*done as a written test in class,*" to prevent dishonest practices and recommending that quizzes "*force the student to focus on modules they might otherwise have skipped.*"

FG2Speaker5's comments revealed a deeper understanding of the motivational impact of grading incentives: "*If there was an incentive, say it was worth 5% of my mark, I might have engaged more.*" This statement illustrated a common sentiment among students that a tangible reward, even as minimal as 5% of the total grade, could significantly alter their engagement strategy. The suggestion to make quizzes "*a part of my continuous assessment grade,*" further emphasised the desire for quizzes to have a direct impact on academic outcomes, enhancing their perceived value.

FG2Speaker8 elaborated on the optimal structure of such incentives: "*Another way to encourage them is to maybe allocate some marks, like one or two marks per quiz.*" The idea of distributing marks across several quizzes suggested a preference for ongoing engagement rather than single high-stakes assessments, fostering a consistent study habit and regular interaction with the course material. The concern for immediate feedback and its role in incentivisation was also highlighted. Immediate rewards, in the form of grades or feedback, catered to the students' need for instant gratification and acknowledgement of their efforts, thereby reinforcing engagement behaviours. FG2Speaker8 noted, "*If there's five quizzes, and you got 1% per quiz, that would be 5% overall ... And it is benefitting you studying too,*" suggesting that small but cumulative incentives can significantly motivate students to engage with quizzes as part of their study routine.

The introduction of meaningful incentives for quiz participation was widely recommended. FG2Speaker8's suggestion for allocating a small percentage of marks

for quiz completion reflected a broader consensus on the need to embed quizzes more firmly within the assessment framework.

7. Device and Location: Influences on Quiz Engagement

The choice of device and location for completing quizzes appears closely linked to participants' convenience, comfort, and the perceived suitability of the content for various screen sizes. FG2Speaker1 and FG2Speaker5 preferred completing quizzes on a computer at home for a more stable and comfortable environment, with FG2Speaker1 stating, "*I just did at home on my computer.*" FG2Speaker3 chose a mixture of iPad and laptop, citing the phone's inadequacy due to screen size and battery consumption: "*I did not use my phone because it eats my battery, and the iPad is bigger. The phone is too small.*"

The environmental context, notably the choice between home and academic settings like libraries or computer labs, also impacts engagement. FG2Speaker8 showed flexibility in completing quizzes "*when I have some free time,*" across different locations, including "*the PC in the computer labs,*" and "at home," suggesting that the quizzes' accessibility across devices and locations supports a more integrated and versatile study practice. The responses showed that this adaptability allows students to incorporate quizzes into their study routines in ways that best fit their individual schedules and learning preferences.

Moreover, the preference for specific devices over others due to usability concerns was evident. FG2Speaker7 avoided the phone because it was "*too slow, and kept freezing,*" underscoring the importance of optimising quiz formats for various devices. Ensuring that quizzes are equally engaging and functional across platforms can help maintain student interest and participation levels, regardless of their chosen device.

Observational Notes and Addressing the Gap

During the second action research cycle, I focused on developing and implementing quizzes to support technology-enhanced formative assessment. These observations over the semester detail the key stages of this process and the challenges encountered along the way.

Developing Quiz Structure and Content

Creating quizzes for the semester proved to be a time-consuming task. Despite having completed similar tasks in the previous semester, each quiz took approximately 12 hours

to design, which was still a significant reduction from the earlier cycle. This decrease in time was likely due to my growing familiarity with the process.

Creating the quizzes involved multiple drafts and re-drafts, with about 10 iterations before finalisation. The process required several steps, including cutting down the number of questions from a larger test bank (typically reducing from 90 to 25), rewording the questions and answers for clarity, and reordering them to align with class topics. Additionally, I included open-ended questions at the end of each quiz to encourage deeper reflection.

Navigating Platform Challenges

I faced considerable uncertainty about whether I could create the final two quizzes on the Learnosity platform due to the company's slow response times in my dealings with them. This challenge caused me concern about meeting end-of-term deadlines. The delay prompted a consideration of other platforms, but switching suppliers would have required additional research and financial resources and at that late stage, would have been taken too long. Ultimately, I decided to continue with Learnosity despite the setbacks, with a contingency plan to complete the quizzes in September if necessary.

Transition to Learnosity and Enhanced Quiz Features

Things worked out well and between myself and the company, we got the Learnosity quizzes up and running in time for them to be deployed for the student. Transitioning to the new platform provided significant benefits. Compared to Moodle's eight question types, Learnosity offered 50 different question types, resulting in a more user-friendly experience with an improved interface. The new platform allowed for a broader range of quiz formats and enhanced interactivity.

By the end of ARC2, I had successfully integrated the Learnosity quizzes into Moodle, linking quizzes 3 and 4. Additional features were implemented to enhance the user experience, including a progress bar to track quiz completion and an attendance block to monitor classroom attendance. Feedback mechanisms were improved, with high-level feedback provided for those scoring above 70% on quizzes, offering encouragement and motivation.

For open-ended questions, I worked on expanding and improving sample answers. I also added a question at the end of each quiz, prompting students to consider which exam questions they might choose, encouraging metacognitive reflection about exam preparation.

Quiz Analysis and Improvements

As the semester concluded, I focused on analysing quiz results and engagement on the two platforms, Moodle and Learnosity. To improve quiz participation, I conducted in-class demonstrations and removed chapter summaries to encourage students to engage with the quizzes directly instead of relying on Word document summaries. This approach aimed to promote deeper engagement and research-based learning.

Professional Development

During the second action research cycle, I continued to develop my capabilities in relation to TEFA through both formal coursework and a variety of professional learning activities. Notably, I completed a 5-credit module at Maynooth University entitled FSS1: Quantitative Statistics. This intensive four-day workshop introduced me to sampling techniques, descriptive and inferential statistics, and practical data analysis using SPSS. This experience deepened my understanding of quantitative research methods and provided me with new skills for designing and evaluating digital assessments.

In addition to formal study, I attended several seminars and conferences that focused on assessment practices, feedback strategies, and technology-enhanced learning. These events included:

- Enhancing Assessment Feedback for Learning (February 2016, Waterford, Ireland) led by Professor Carol Evans, an expert in higher education pedagogy and assessment feedback.
- Collaboration and Innovation: Enhancing Inclusive Formative and Summative Assessment (February 2016) with presenters from the Special Education Department at St Patrick's College, DCU, focusing on diverse assessment approaches for large and small class settings.
- Innovations in LMSs for Assessment: Formative and Summative Approaches (organised by staff from MIC, LIT, UL, and the University of Oxford), exploring creative uses of learning management systems to improve student engagement and assessment practices.
- Action Research Group Ireland (June 2016) featuring keynotes by Mary Brydon-Miller, David Coghlan, and Margaret Gearty, which provided insights into various methodologies and ethical considerations in action research.

- Network Educational Action Research Ireland (NEARI) (March 2016) with Jack Whitehead, focusing on the 'messiness' of action research and ways to enhance educational influences in learning.
- Maynooth Education Technology Showcase (METS 2016), a "Carnival of Creative Learning" aimed at sparking innovative ideas in educational technology.
- A Learnosity seminar highlighting new developments in question types and platform functionality.

I read several key academic readings throughout the semester. These included critical literature reviews and research studies on technology-enhanced learning (Kirkwood and Price, 2013a, 2014), reflections on effective academic research in education technology (Selwyn, 2012), and best practices for using statistics in educational research (Trochim and Donnelly, 2006; Field, 2009; Dorling, 2013). I also explored policy-oriented documents such as The Changing Pedagogical Landscape (Haywood et al., 2014) and the High Level Group on the Modernisation of Higher Education (McAleese and Vassiliou, 2014), which helped me situate my work within broader discussions on the future of teaching, learning, and assessment in higher education.

Finally, I shared the evolving outcomes of my research in several academic forums. I presented preliminary findings from this action research at the EdTech 2016 conference and more detailed insights from the first two cycles at the European Conference on Educational Research (ECER 201). I also contributed to the What Works Why project, publishing some of my initial research findings in a collective volume. These opportunities for dissemination allowed me to refine my research design and further develop my expertise in TEFA, as I received feedback from peers and experts in the field.

These observations reflect the challenges and progress made during the second action research cycle. Again, this experience offered insights into the ongoing development and implementation of TEFAs in an academic context and how things could be improved for the next cycle.

Conclusions and Planning for Next Cycle

ARC2 finding reveal certain themes emerging that would inform improvements in ARC3. A significant observation was the decreasing trend in student quiz engagement as the semester progressed. Despite quiz design enhancements, initial engagement was

high but gradually decreased. This unexpected trend requires a re-evaluation of engagement strategies to maintain student interest throughout the semester.

The use of different platforms (Learnosity and Moodle) revealed variations in student engagement and preferences. While Learnosity quizzes were slightly favoured for their clarity and motivational impact, Moodle quizzes maintained their higher engagement levels. This suggests the importance of platform consistency and familiarity in influence student interaction.

End of the semester surveys indicated that students generally found the quizzes as engaging, clear, and helpful, although views on their motivational impact and length were mixed. These perceptions underline the need for a more flexible and diverse content approach in quiz design, accommodating various learning approaches and the time constraints of students.

A key aspect of ARC2 was the impact of quizzes on learning outcomes. The quizzes were highly regarded for their role in exam preparation and enhancing engagement with module material. However, the direct correlation with improved exam grades was less clear, suggesting a need for further investigation and adaptation of quiz content to directly support learning objectives.

Focus group discussions revealed diverse levels of student engagement, from high to none, highlighting the need to address individual student needs and preferences. Students preferred concise, engaging quizzes with clear feedback, moderate difficulty, and varied question types. These preferences will guide future quiz development, ensuring alignment with student expectations and learning styles.

Additionally, valuable insights into the strategic use of quizzes by students for focused studying were gleaned. Students used quizzes to identify knowledge gaps and to concentrate on specific topics, indicating their potential as a targeted learning tool. Quiz timing and scheduling were also critical. Quizzes should be strategically scheduled to align with teaching topics and offer relevance at the most opportune times. Based on this feedback, introducing quizzes earlier in the semester may also encourage earlier revision.

These ARC2 observations presented another opportunity to refine and enhance the quiz-based learning approach in ARC3. This involved implementing strategies to maintain and boost engagement throughout the semester, ensuring platform consistency, offering diverse and relevant quiz content, and aligning quizzes more closely with course

objectives and learning outcomes. Improved communication and support, clearly communicating the purpose and benefits of quizzes, should improve quiz attempts. Clear, accurate, and helpful feedback is a priority, with the possibility of more detailed feedback on open-ended questions being explored. Continuous feedback from students remained a crucial component in this iterative process. It was hoped that this would enable ongoing adaptation and improvement of the quiz design and implementation.

5.3. Action Research Cycle 3 (ARC3)

The third action research cycle (ARC3) occurred in Semester 1 of the next academic year with a new group of students. Throughout this period, data were gathered, including quiz results, a mid-semester survey, and an end-of-semester survey. Detailed analyses and explanations of these data are presented in the subsequent sections.

Mid-Semester Survey

In the midst of ARC3, a mid-semester survey was administered following the release of four quizzes. From the 64 students who responded, 63% had engaged with at least one quiz up to this point in the semester, while 37% had not engaged in any quizzes. Looking ahead to the final exam in Week 17, among the 24 students who had yet to take a quiz, a majority (63%) indicated they planned to attempt one. However, 29% were uncertain, responding with 'Maybe', and a mere 8% expressed no intention to partake in the quizzes before the final exam.

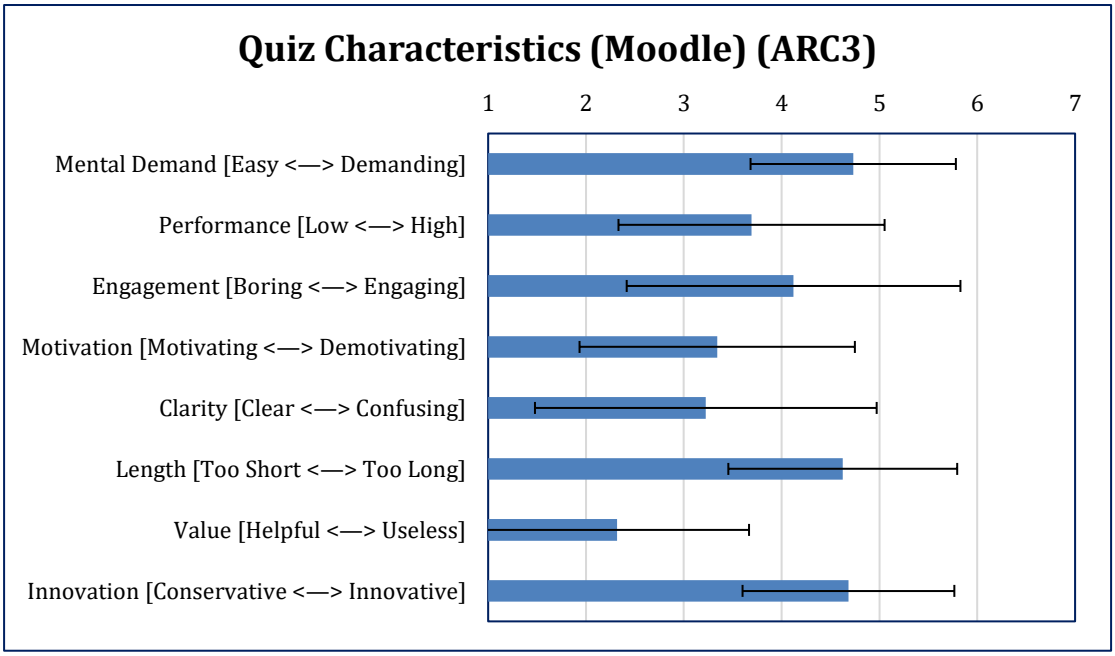


Figure 35. Quiz Characteristics (Moodle) [ARC3 Mid-Semester]
Note: Scores indicate averages on a 7-point Likert-type scale. Error bars indicate±1 SD

The same set of questions from the mid-semester survey in ARC1 were used in this survey to gauge students' perceptions of the quizzes. Again, these questions addressed aspects such as mental demand, performance, engagement, motivation, and clarity. Since this group of students were new to the quizzes, it was important to revisit questions regarding helpfulness and innovation to capture fresh perspectives. The findings below provided a comparative view of this group's quiz experience.

Students rated the quizzes as moderately demanding, with an average of 4.73 (SD = 1.05); 59% found the quizzes demanding, 29% were neutral. Performance received a mixed response, averaging 3.69 (SD = 1.36), with 44% rating their performance on the lower side, and an equal division between neutral (28%) and higher performance (28%), suggesting varying levels of success in quiz completion. Engagement levels were positive, averaging 4.12 (SD = 1.71), as 46% found the quizzes engaging, while 29% felt bored, and 24% were neutral. Motivation scored 3.34 (SD = 1.41), with 54% feeling motivated by the quizzes, although 24% felt demotivated and 22% were neutral, indicating diverse motivational responses.

The clarity of the quizzes received favourable ratings, with an average score of 3.23 (SD = 1.75); 58% found them clear, though 25% were confused, and 18% were neutral. Quiz length, averaging 4.63 (SD = 1.17), was deemed too long by 40%, while 8% found it too short, and 53% had no strong opinion, indicating possible general satisfaction. Helpfulness scored highly, with an average of 2.32 (SD = 1.35), as 83% found the quizzes useful, contrasting with 12% who found them less beneficial and 5% remaining neutral. Lastly, the quizzes' perceived innovation scored 4.68 (SD = 1.08), with 51% viewing them as innovative, 7% as conservative, and 41% holding a neutral stance, indicating a moderate reception of the quizzes' novelty.

These findings reflected a general positivity towards the quizzes, particularly regarding their usefulness and engagement value, while also highlighting areas for further refinement, such as balancing quiz length and ensuring an optimal level of challenge and innovation to maximise their effectiveness. Comparing with previous cycle, the findings remained consistent with patterns observed in ARC1 and ARC2, reflecting both ongoing strengths and areas needing further refinement. Students continued to perceive the quizzes as moderately demanding, somewhat below the high mental demand ratings seen in early ARC1. While engagement is generally positive, it did not quite reach the higher levels noted at the end of ARC2. Motivation similarly showed a

mixed response to ARC1, falling short of the stronger motivational ratings reported in ARC2. On the positive side, clarity remained favourable, indicating that design improvements from earlier cycles have endured. Although some students still viewed the quiz length as excessive, the concern appeared less pronounced than in ARC1 and, in some respects, echoes the neutrality shift recorded during ARC2. Helpfulness again stood out as a key strength, improving on the already high marks from previous cycles. Finally, students perceived a moderate degree of innovation, consistent with the steady enthusiasm observed throughout ARC1 and ARC2, though the slight peak gains at the end of ARC2 appeared to have levelled off.

Responses to the Open-Ended Survey Questions

For both the mid-semester and end-of-semester surveys in this cycle, the thematic findings are presented separately for students who engaged with the quizzes and those who did not. This approach was taken to gain a deeper understanding of the specific factors influencing engagement and lack of engagement at this stage of the research. By distinguishing between these two groups, it was possible to explore their motivations, barriers, and perspectives in more detail, providing richer insights into how students interacted with the quizzes.

The mid-semester survey responses that follow revealed a range of reasons for engagement and disengagement, reflecting diverse student circumstances and attitudes.

Non-Engagement with Quizzes

This section examined why a number of respondents did not participate in the online quizzes. It outlines various constraints and preferences that have influenced their decision to abstain from this learning activity. The insights here revealed a range of challenges such as limited time, prioritising compulsory coursework, access to technology, and individual study habits. By understanding these barriers, I could consider how to adjust the delivery and promotion of online quizzes to better fit into the diverse and sometimes constrained schedules of students. The following are the main challenges and preferences that have influenced their decisions to abstain from this learning activity.

1. Time Constraints and Academic Workload

The most recurrent theme among the students' reasons for not engaging with the quizzes pertains to time constraints, often due to competing academic demands. Students felt the pressure of their schedules, with one noting the specific challenge of "*Too many C.A.'s recently so plan to attempt them as part of revision*." Another student's daily routine leaves little room for additional study, as they only "*have 2 hours when I get home to do study and work due to 5 am wake times and home by 8 on average*." These reflections bring to the forefront the tight constraints within which students are operating and the consequent difficulty in fitting in extra, non-mandatory activities like quizzes.

2. Perceived Utility and Priority

The perceived importance and utility of the quizzes are questioned by several students, often in relation to their non-mandatory nature. One student expressed this quite candidly, stating, "*It's not mandatory to complete so I prioritise mandatory assignments.*" This sentiment was echoed by another who felt that "*the quizzes aren't a priority as there is no consequence if I didn't do them*," suggesting that the optional quizzes are overshadowed by the more immediate demands of graded coursework.

3. Digital Access and Connectivity Issues

Access to reliable internet was a practical barrier for some students. One student's circumstance, "*I don't have wifi at home so I'd have to do it in college*", highlighted the digital divide that can prevent engagement with online resources, a factor that is often overlooked but crucial for accessibility.

4. Personal Study Preferences and Strategies

Students' individual study habits and preferences also played a significant role in their engagement with the quizzes. Some students chose to stick with familiar study methods, as one student's comment makes clear, "*I don't normally do quizzes; they aren't of interest to me*." Others said they planned to use the quizzes strategically later in their study process, as indicated by the intention to use them "*as a way of tracking my progress with my revision,*" after more traditional forms of revision had been completed.

5. Motivation

A lack of motivation was an underlying factor for some students not engaging with the quizzes. Straightforward admissions of "*Lazy,*" from one respondent and "W*asn't*

bothered," from another, point to motivational barriers that can impede the uptake of supplementary learning tools.

6. External Commitments and Life Balance

The challenge of balancing academic commitments with other aspects of life, such as work and personal responsibilities, is evident in the student responses. "*Too busy. I work weekends so time constraint is a huge problem for me*," one student remarked, illustrating the juggling act many students face.

7. Procrastination and Planning

Some responses indicated a degree of procrastination or a planned delay in using the quizzes. Statements like "*Haven't had time yet but plan to attempt all over Xmas*," reflect an intention to engage with quizzes at a more convenient time, often during a break when other academic pressures may be less intense.

As described above, the reasons for lack of quiz engagement with TEFAs were complex. It involved practical limitations, individual preferences, and strategic study choices. These findings highlighted the importance of considering these diverse factors when evaluating and designing online quizzes for revision, ensuring they meet the varied needs and circumstances of the student body.

Engagement with Quizzes

Students who participated in the quizzes reported a range of experiences and perceptions regarding their usefulness and design. This section examined the experiences of these students, highlighting the quizzes' role in their study routines, their value as a review method, and their contribution to understanding the course material. Feedback on the quizzes' structure and content suggests areas for improvement, indicating that while valued, their format and timing could be better tailored to student needs and preferences.

1. Revision and Preparation

For many students who engaged with the quizzes, they served as a valuable tool for revision and assessing their grasp of the material. One student found the quizzes to be an *"Excellent idea, very helpful at identifying areas to focus on for final exam,"* which highlighted the quizzes' role in guiding study priorities. Another student mentioned, *"Great revision exercise,"* which reinforced the idea that quizzes can effectively consolidate learning.

2. Initial Hesitance and Subsequent Recognition of Value

A few students noted that there was an initial hesitance to start the quizzes due to fear of underperformance. As one student admitted, *"It took me a while to start the quizzes, out of fear of being unable to answer questions."* However, once overcome, the quizzes were recognised as beneficial, suggesting that initial reluctance could be mitigated by encouraging students to view quizzes as low-stakes opportunities for self-assessment.

3. Quiz Structure and Clarity

The structure of the quizzes prompted mixed responses. The clarity of short questions was appreciated, *"Short Qs clear,"* yet the long questions sometimes caused confusion: *"Long Qs confusing."* A few respondents drew attention to this dichotomy and indicated a need for clearer instructions and possibly examples of expected answers to guide students, especially for longer, more complex questions.

4. Feedback on Learning and Areas of Improvement

The quizzes provided feedback that was instrumental in helping students identify knowledge gaps. The process of answering questions and immediately seeing results allowed students to pinpoint what they needed to review further, as one student put it, *"Quiz was good ... Gave me a good idea of what I need to cover after the quiz."* This direct application of the quizzes to inform study direction was echoed by another student who used the quizzes as a barometer for progress, stating, *"Good way of seeing how you're getting on what work needs to be done."*

5. Content Familiarity and Guesswork

Some students used the quizzes without prior revision, relying on memory or intuition. As one student reported, *"Some of the answers I gave were guess work. I had not even looked at the notes."* This indicated that the quizzes were sometimes approached spontaneously, without the preparatory work that might make them more effective.

6. Instructions and Expectations for Answers

Students sought clearer guidance on quizzes, especially regarding the length and depth of answers required for open-ended questions. One student suggested, *"Maybe with the longer questions with no multiple choice, mention how many words minimum,"* which pointed to a need for precise instructions to aid students in providing adequately detailed responses.

7. Assessment Strategy and Learning Engagement

The strategy of using quizzes for self-assessment was highlighted by students who planned their engagement around their revision schedules. One student explained they were *"waiting for revision to answer the quizzes as a means of study and to see how far I'm getting on."*

8. Perceptions of Length and Interest

Quiz length influenced student engagement. One student noted, *"Helpful, however in my opinion it was a bit too long and as a result I lost interest."* Other comments suggested that while quizzes are beneficial, their length and pacing need adjustment to maintain student interest and engagement.

In conclusion, participating students valued the quizzes, offering suggestions for design and implementation improvements. Their experiences reflected the importance of quizzes in providing structure to revision, clarifying learning outcomes, and offering flexible yet structured opportunities for self-assessment.

Moodle Engagement Logs and Quiz Data

The figures below analysed student engagement with Moodle and quiz activities during ARC3, highlighting patterns of usage across the semester. The data demonstrated how quiz participation fluctuated in response to key academic periods, such as the mid-term break, Christmas holidays and the final exam preparation phase. Generally, in ARC3, we saw a much higher percentage of Moodle users participating in quizzes.

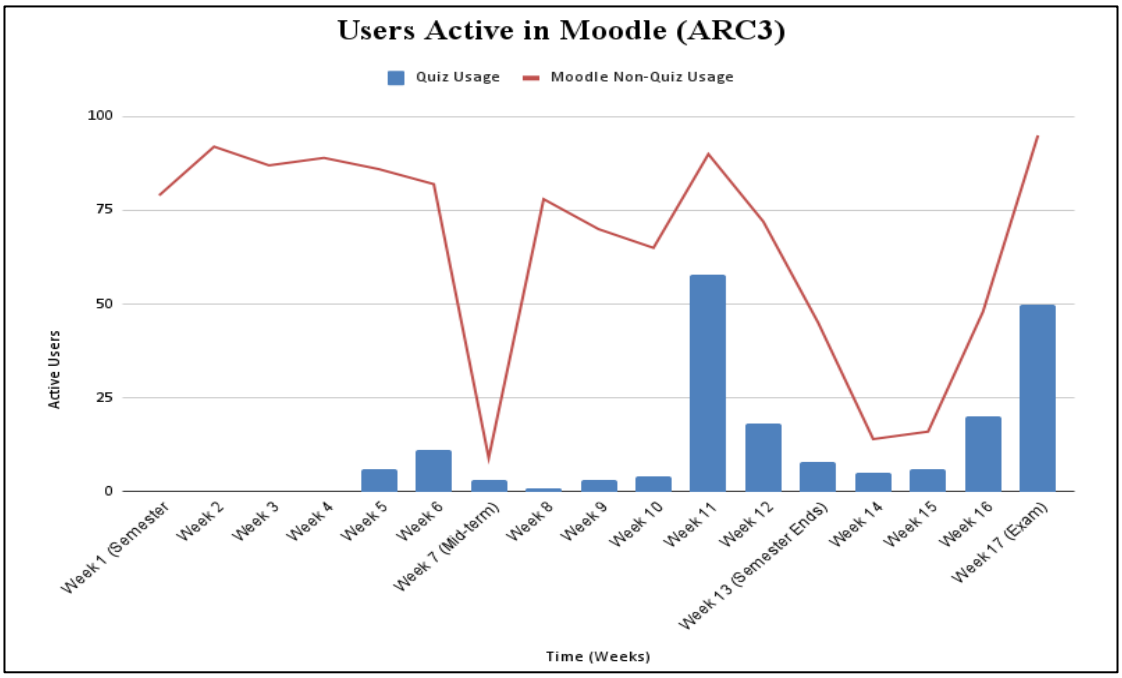


Figure 36. Weekly VLE Engagement Analytics [ARC3]

Figure 36 displays the weekly Moodle usage in ARC3, showing both overall active users (red line) and quiz submissions (blue bars). As in ARC1, Moodle usage gradually rises but dips around mid-term (Week 7) and during the Christmas break (Weeks 13-14). Unlike ARC2, where engagement remained low throughout most of the semester, ARC3 exhibits a clear increase in Moodle activity closer to the final exam period, especially in quiz submissions. This peak, reaching its height in Week 17 (exam week), indicates that quizzes were heavily utilised as a study aid, a behaviour not as pronounced in ARC2. The increase in Moodle usage may reflect both heightened familiarity with the platform and the perceived relevance of quizzes to exam preparation, suggesting improvements in the design or timing of quizzes in ARC3 led to greater engagement than in ARC2, where only modest peaks were observed late in the semester.

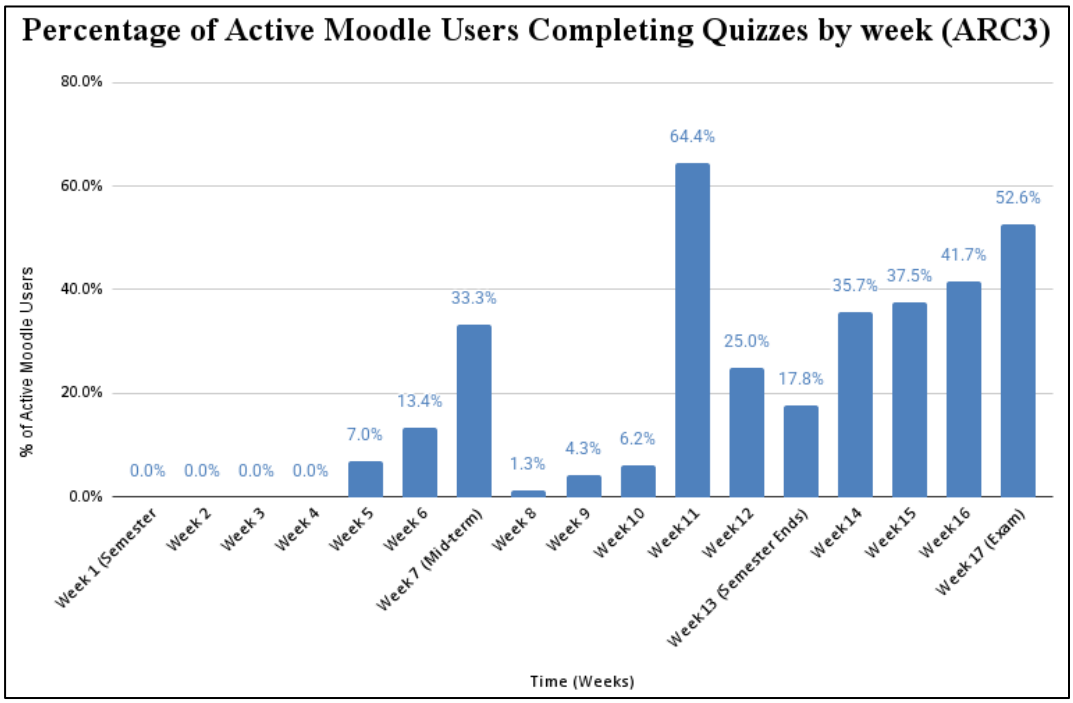


Figure 37. Percentage of Active Moodle Users Completing Quizzes [ARC3]

Figure 37 shows the percentage of active Moodle users who completed quizzes each week. ARC3 data highlights a series of peaks, with early engagement before the mid-term, as seen in ARC1 and ARC2, but with significantly higher participation closer to the final exam. In ARC2, quiz engagement remained relatively low across most of the semester, with only 11% of active users completing quizzes mid-semester and around 30-35% in the final weeks. By contrast, ARC3 saw participation rates rise to 41.7% in the weeks before the exam, with a peak of 52.6% in the exam week. This suggests a clear increase in quiz engagement compared to ARC2, indicating that students in ARC3

found the quizzes more beneficial as a structured revision tool, possibly due to platform or content adjustments that aligned better with exam preparation needs.

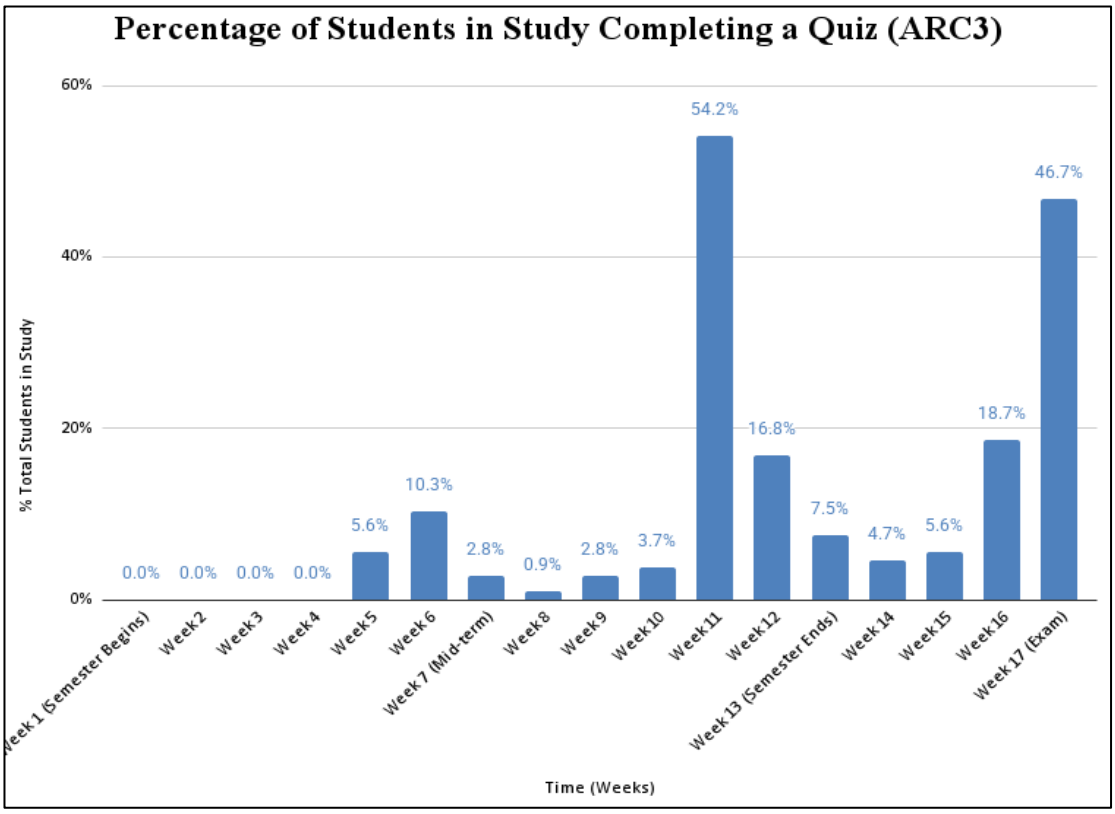


Figure 38. Percentage of Active Moodle Users Engaging with Quizzes [ARC3]

Figure 38 illustrates quiz completion rates as a percentage of the total study cohort, providing insight into broader engagement patterns across ARC3. Early in the semester, quiz completion remains low, with a notable increase starting around Week 6. At this time, I made a conscious effort to boost engagement, which appears to have had a positive, though temporary, effect. By Week 11, quiz participation reaches a significant peak of 54.2%, indicating strong engagement towards the end of my lectures. Following a slight drop, engagement picks up again and remains consistent over the Christmas period (Weeks 14-16), culminating in a final spike of 46.7% during exam week (Week 17).

This sustained engagement over the holiday period and the strong peak in Week 11 suggest that the quizzes were increasingly viewed as valuable study aids and not just being left to the week or night before like in previous cycles. Unlike ARC2, where quiz usage was concentrated almost entirely in the final two weeks, ARC3 shows a more distributed pattern of engagement, with consistent usage both mid-semester and in the exam preparation phase. These patterns imply that adjustments made to the quizzes,

coupled with strategic engagement efforts, were effective in encouraging students to integrate quizzes more thoroughly into their study routines across a broader timeframe. Overall, ARC3 exhibits higher Moodle engagement and quiz participation than ARC2, especially in the weeks leading up to exams. The change from Learnosity in ARC2 back to Moodle in ARC3, combined with design adjustments, seems to have made quizzes more accessible and useful for students' revision, as seen in the heightened engagement. Unlike ARC2, where engagement was primarily restricted to the final two weeks, ARC3 shows consistent increases in both Moodle activity and quiz completion throughout the semester, reaching significantly higher percentages near exam time. This suggests that changes implemented in ARC3, possibly in quiz format, content, and accessibility, contributed to a more effective integration of quizzes into students' study habits, supporting a higher level of overall engagement compared to both ARC1 and ARC2.

Quiz Data Analysis

Quiz	Attempts	No. of Clickthroughs	No. of Students	Average no. of attempts / student (CTR)	% of students on module	No. of Questions	Date Issued
Quiz 1	121	12	79	1.53	74%	17	Week 5
Quiz 2	51	17	37	1.38	35%	20	Week 6
Quiz 3	41	8	33	1.24	31%	17	Week 9
Quiz 4	27	6	22	1.23	21%	16	Week 9
Quiz 5	18	7	11	1.64	10%	14	Week 13
Total	305						

Table 6. General Quiz Data [ARC3] (N=107)

Note: Attempts refers to the number of times each quiz was completed. No. of Clickthroughs represents instances where students accessed the quiz page without completing it, while No. of Students indicates the unique number of students who completed each quiz at least once.

Table 6 summarises student engagement with quizzes during this cycle, Notably, Quiz 1 is a new addition covering Chapter 1, which did not have a corresponding quiz in ARC1. This introduction of Quiz 1 led to the highest number of attempts in ARC3, indicating strong engagement early in the semester. As the semester progressed, a decline in attempts is observed from Quiz 2 to Quiz 5, reflecting a similar trend seen in previous cycles, where participation typically tapers as students advance through the term. The quizzes varied slightly in question count, but this variation did not appear to significantly influence the number of attempts. This pattern suggests a common decrease in participation over time, likely influenced by increasing academic demands or other coursework priorities.

.

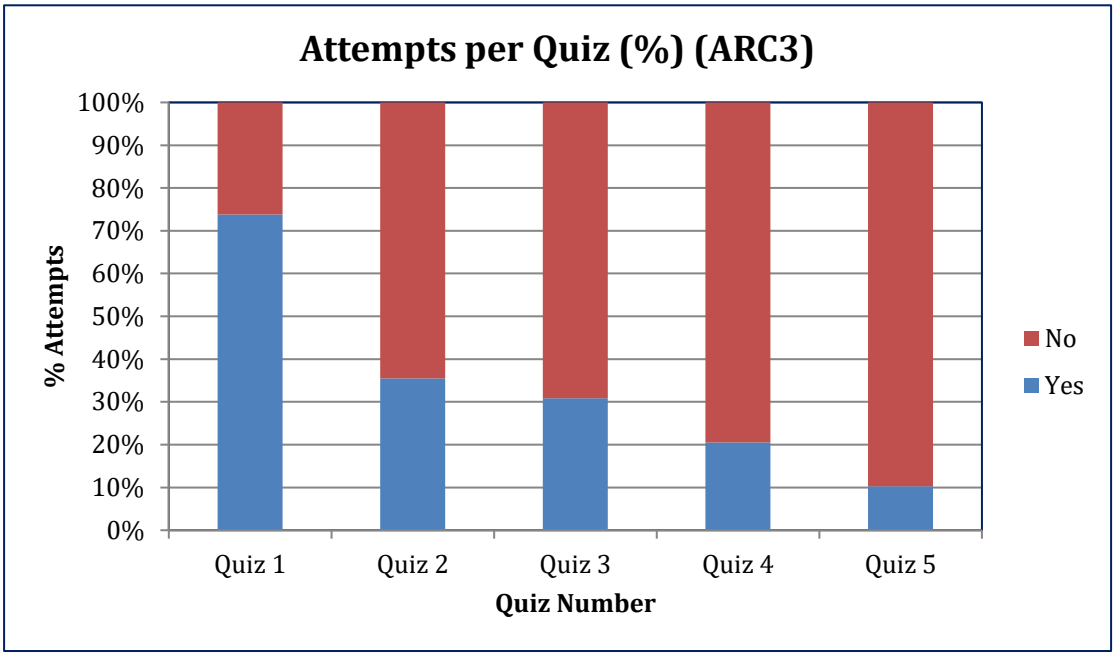


Figure 39. Number of Attempts per Quiz (ARC3)

Figure 39 shows completion rates across a sequence of five quizzes for a total cohort size of 107 students over this research cycle. For Quiz 1, a minority comprising 26% (n=28) of the cohort did not participate, whilst the majority, 74% (n=79), completed the quiz. In contrast, Quiz 2 saw a notable shift, with 64% (n=69) opting out and only 36% (n=38) attempting the quiz. This pattern persisted in Quiz 3, where 69% (n=74) did not participate, leaving 31% (n=33) who did. The trend towards decreased participation continued with Quiz 4, as 79% (n=85) refrained from attempting the quiz, contrasting with 21% (n=22) who partook. The most marked decline was observed in Quiz 5, with 90% (n=96) of students not attempting the quiz, compared with 11% (n=11) who did. Only seven students completed all five quizzes.

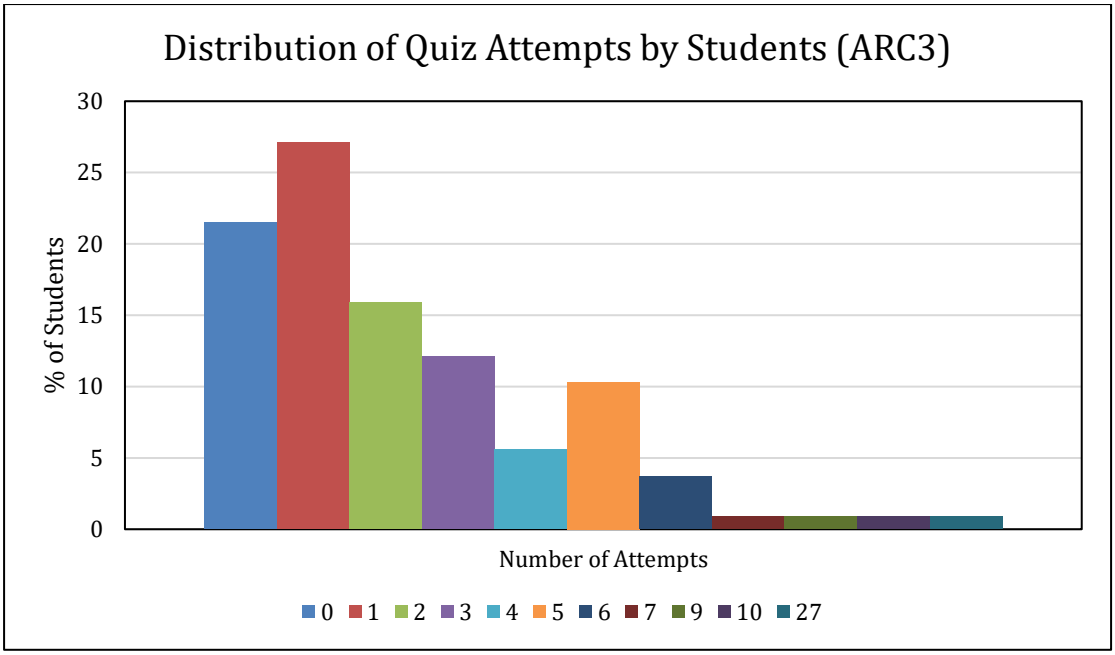


Figure 40. Distribution of Total Quiz Attempts by Students

This figure illustrates the percentage of students who attempted a specific number of quizzes in ARC3. Each bar represents the proportion of students who made that number of attempts across all available quizzes in the cycle. A total of 21.5% of students (n=23) made no attempt at any of the quizzes. The largest group, 27.1% (n=29), attempted only 1 quiz. Following this, 15.9% of students (n=17) attempted 2 quizzes, and 12.1% (n=13) attempted 3 quizzes. A smaller percentage engaged with the quizzes more frequently: 5.6% (n=6) attempted 4 quizzes, 10.3% (n=11) attempted 5 quizzes, and 3.7% (n=4) attempted 6 quizzes. Very few students attempted more than six quizzes. This distribution indicates that while a significant portion of students engaged with at least 1 quiz, sustained engagement across multiple quizzes was less common. However, almost 80% of students attempted at least 1 quiz, which is an improvement on the previous cycles.

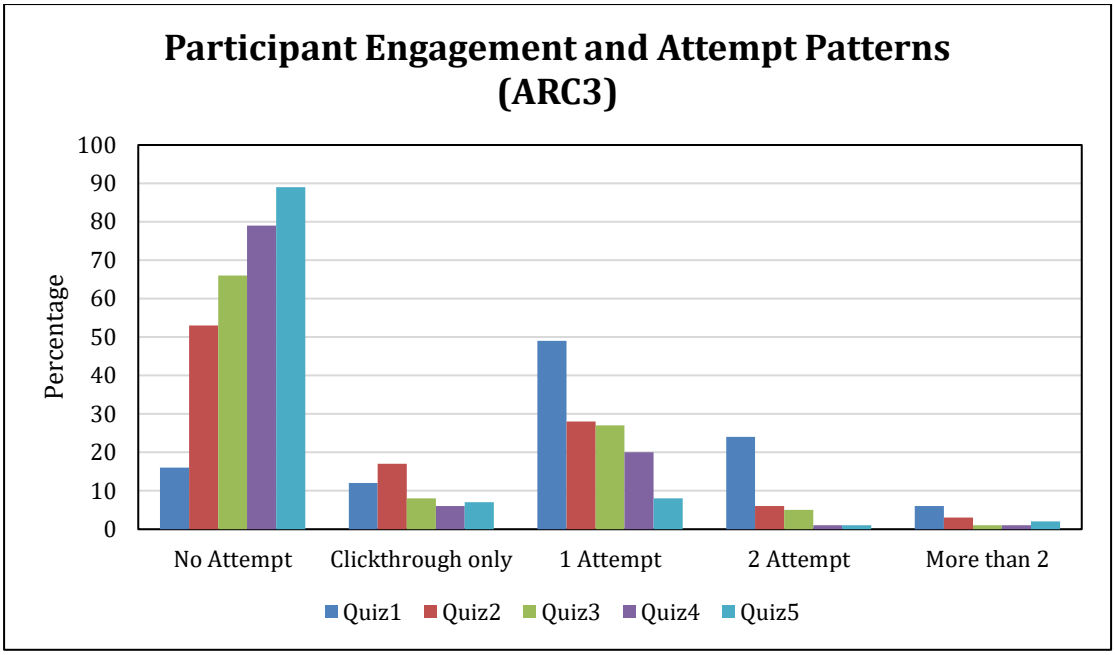


Figure 41. Participant Engagement and Attempt Patterns [ARC3]

This graph shows engagement and attempt patterns for 5 quizzes among the cohort of 107 students. It shows a clear decline in engagement from Quiz 1 to Quiz 5. Quiz 1 recorded the highest level of engagement with 91 out of 107 students clicking through or attempting the quiz in some form. The numbers reduce progressively for subsequent quizzes, with Quiz 2 showing a drop, as only 54 students clicked through or attempted it. This downward trajectory continues with Quiz 3, seeing fewer students interacting, and even more pronounced by Quiz 4, with only 28 students engaging. Quiz 5 marks the lowest point of engagement, with a mere 18 students clicking through or attempting.

In terms of attempts, Quiz 1 saw the highest number of students making an attempt, and the numbers for both one-time and multiple attempts gradually decrease for each subsequent quiz. The number of students not engaging at all starts at 16 for Quiz 1 and rises to 89 by Quiz 5, indicating a clear trend of diminishing interaction.

Across all quizzes, the proportion of students who attempted the quiz more than once is consistently lower than the number of students attempting the quiz only once. Moreover, the pattern suggests that as the quiz sequence progresses, students are increasingly less likely to engage with the quizzes, with the sharpest drop seen between Quiz 1 and Quiz 5.

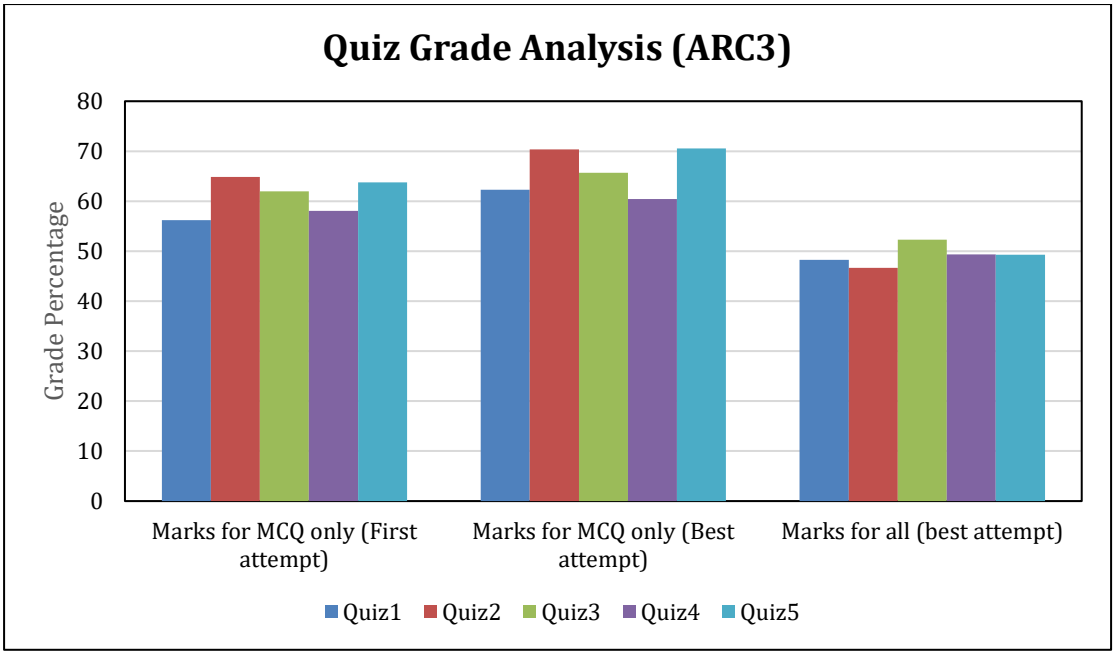


Figure 42. Detailed Analysis of Quiz Attempts [ARC3]

Figure 42 illustrates the performance of participants across five quizzes comparing their first attempt on multiple-choice questions (MCQs) only, their best attempt on MCQs, and their best attempt across all question types. The first attempt on MCQs shows scores ranging from 56.18 to 64.82, with a notable increase from Quiz 1 to Quiz 2, and a slight dip at Quiz 4, representing participants' initial understanding of the material, without the benefit of additional attempts. In contrast, the best attempt on MCQs reflects higher scores, from 62.29 to 70.55, indicating improvements through subsequent attempts, particularly in Quizzes 2 and 5. The best attempt across all question types (both MCQs and open-ended questions) yields lower scores, ranging from 46.63 to 52.27, suggesting that participants found open-ended questions more challenging. This disparity in scores highlights the potential difficulty students faced with open-ended questions, which may have lowered overall quiz performance, even with multiple attempts. Notably, in Quiz 3, the best attempt score is lower than the first attempt score, suggesting that the inclusion of open-ended questions posed a greater challenge. This could point to participants not attempting all open-ended questions or to a need for further instruction or support in this area. The results raise important considerations about the balance of assessment types in quizzes and suggest that students may benefit from additional practice or feedback on open-ended questions, which could enhance their performance in future assessments.

Correlation Data (Attendance, Exam Results, Quiz Attempts)

Variables	Best Q1	Best Q2	Best Q3	Best Q4	Best Q5
N	79	38	33	22	11
Theory	.340**	.217	-.228	.436*	-.177
Overall Grade	.355*	.283	-.129	.457*	-.266
Attendance	-.059	-.166	-.044	-.048	.224

*Note: * Correlation significant at 0.05 level. ** Correlation significant at .01 level. Best signifies students highest result in that quiz.*

Table 7. Correlations: Quiz Attempts, Attendance and Academic Performance [ARC3]

Following on from Figure 42, Table 7 presents Spearman's Rho data on the students' best quiz attempts (including both MCQ and Open-Ended Questions) and their theory grades, overall grades, and attendance. Due to the small number of students who completed all five quizzes in ARC3 (only seven students finished all five quizzes, with particularly low numbers for Quizzes 4 and 5) it was not meaningful to aggregate quiz performance across all quizzes, as was done in ARC1 and ARC2. Instead, comparisons were made based on each student's best performance in individual quizzes.

There is a statistically significant positive correlation between quiz performance on Quiz 1 (Q1) and theory grades, with r_s (77)=.340, p=.002, and between Q1 and overall grades with r_s (77)=.355, p=.001. Although weak, this suggests that higher performances on Q1 are associated with slightly better academic outcomes. The correlation is somewhat stronger between Quiz 4 (Q4) and theory grades with r_s (20)=.436, p=.042, and Q4 and overall grades with r_s (720)=.457, p=.033. Considering that fewer people have taken Q4, this is based on a smaller sample, but suggests a small relationship between Q4 and academic performance. As can be seen in Table 7, there were not statistically significant correlations between Quiz performances and attendance.

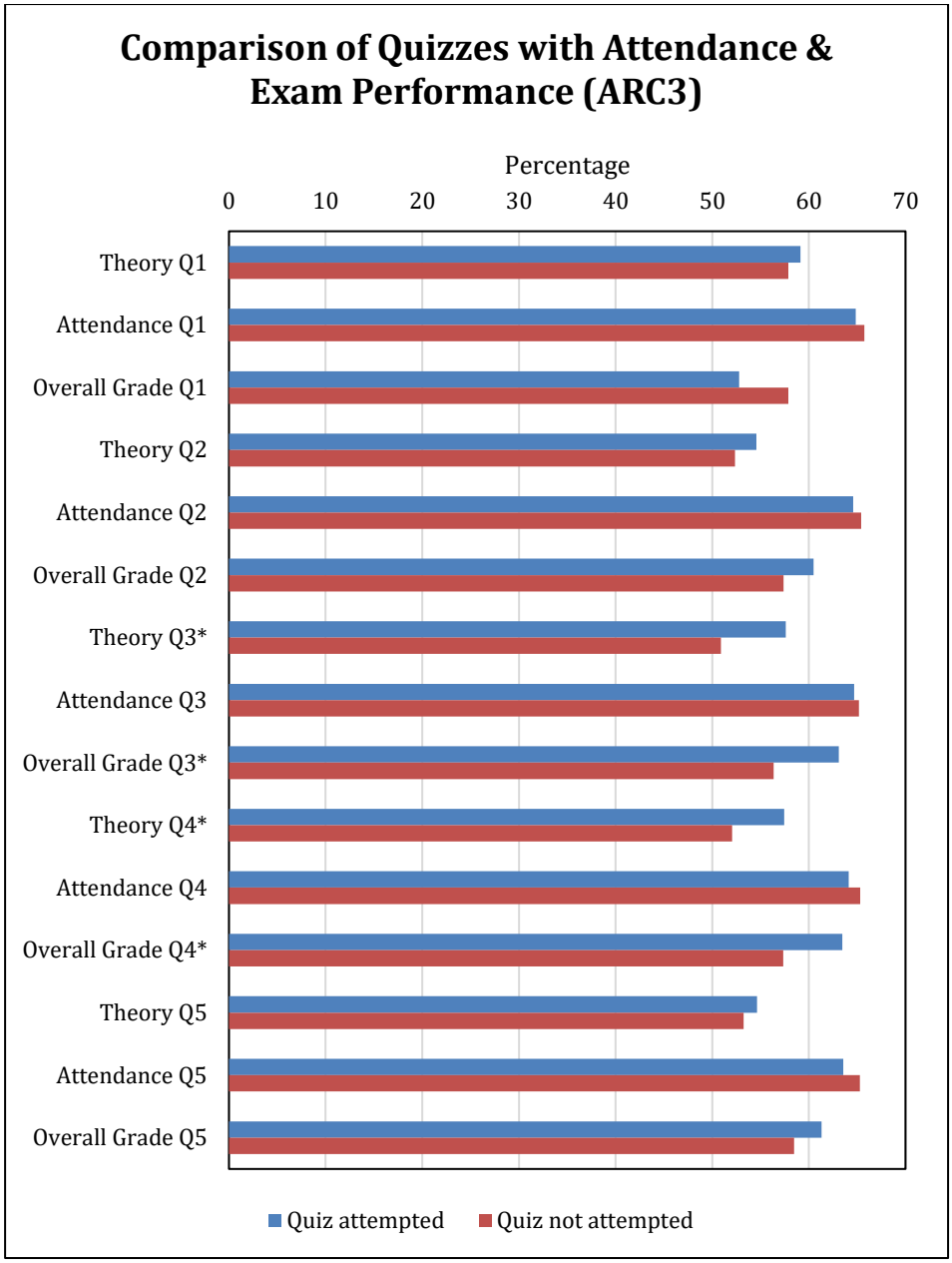


Figure 43. Comparison of Quizzes with Attendance & Exam Performance [ARC3]

*Note: Each grouping compares the differences in averages between those who have attempted or not attempted quizzes for attendance and academic performance. For example, "Attendance Q3," compares overall attendance and attempts/non-attempts of Quiz 3.*denotes significance.*

While Table 7 explored the correlations between quiz performance, attendance, and academic outcomes, Figure 43 compares the performance of students who attempted quizzes with those who did not, focusing on theory grades, attendance, and overall grades across five quizzes. This analysis does not focus on attendance within the specific week of each quiz release but rather examines the overall correlation between attendance, quiz attempts, and academic performance (Theory and Overall Grades) across each quiz (i.e. Q1 is Quiz 1) in ARC3. This analysis provides insights into the

relationship between quiz participation and academic performance, particularly in the context of theory grades, which reflect final exam performance, while overall grades include a practical lab exam.

The differences in theory grades between quiz takers and non-quiz takers are generally modest across the quizzes. The most notable variance occurs in Quiz 3, where quiz takers scored an average of 57.6, compared to 50.9 for non-quiz takers. A similar difference appears in Quiz 4, where quiz takers averaged 57.4, compared to 52.1 for non-quiz takers. Given that the theory exam represents 70% of the overall grade, these differences suggest that quiz attempts may contribute to a better understanding of the exam material.

Attendance rates show minimal variation between quiz takers and non-quiz takers. In some cases, non-quiz takers had slightly higher attendance, such as for Quizzes 1 and 5. This indicates that quiz participation does not necessarily align with higher attendance.

More substantial differences are seen in overall grades for Quizzes 3 and 4. Quiz takers in Quiz 3 achieved an average overall grade of 63.1, compared to 56.4 for non-quiz takers, and a similar pattern appears in Quiz 4. However, as the overall grade includes a practical lab exam worth 30%, these differences may reflect performance in areas beyond theory.

To assess the differences statistically, t-tests were performed for each quiz on theory grades, overall grades, and attendance. Statistically significant differences were observed in theory and overall grades for Quizzes 3 and 4, as indicated by the asterisk in Figure 43. There was a statistically significant difference in theory scores for quiz 3 takers (M =57.60, SD = 10.81) and non-quiz 3 takers (M =50.91, SD =12.97); t (105) = 2.76, $p.$ = .007. The magnitude of the difference between the means (mean difference = 6.69, 95% CI: 11.49 to 1.88) was small (eta squared = 0.01). There was also a statistically significant difference in total grades for quiz 3 takers (M =63.09, SD = 10.14) and non-quiz 3 takers (M =56.37, SD = 12.49); t (105) = 2.90, $p.$ = .005. The magnitude of the difference between the means (mean difference = 6.71, 95% CI: 11.30 to 2.12) was moderate (eta squared = 0.07). For quiz 4, there was a statistically significant difference in total grades for quiz 4 takers (M =63.45, SD = 9.90) and non-quiz 4 takers (M =57.35, SD = 12.40); t (105) = 2.35, $p.$ = .021. The magnitude of the difference between the means (mean difference = 6.10, 95% CI: 11.25 to 0.96) was

small (eta squared = 0.05). This suggests there for quizzes 3 and 4, those who took the quizzes performed a bit better. However, no significant differences were found for Quizzes 1, 2, and 5. This might mean that these quizzes were not as important for academic success.

End of Semester Survey

The End of Semester Survey elicited 40 responses out of 101 students. A vast majority of the respondents, 80% (32 individuals), reported having completed at least one quiz during the semester. Conversely, 20% (8 respondents) had not engaged with any of the quizzes. Among those who had not participated, a significant 89% anticipated attempting a quiz in the subsequent Semester 2. The detailed perspectives and explanations of both those who did and did not engage with the quizzes are explored in the *Responses to the Open-Ended Survey Questions* section. The subsequent section provides an analysis of the quantitative data gathered through the survey questions. The variables here are the exact same as those asked in the end of semester survey in ARC1. As explained in ARC1, the rationale for including fewer variables (Mental Demand, Performance, Innovation) in this survey compared to the mid-semester survey (Figure 35) remains the same. Similar to ARC1, three additional variables are described in Figure 45.

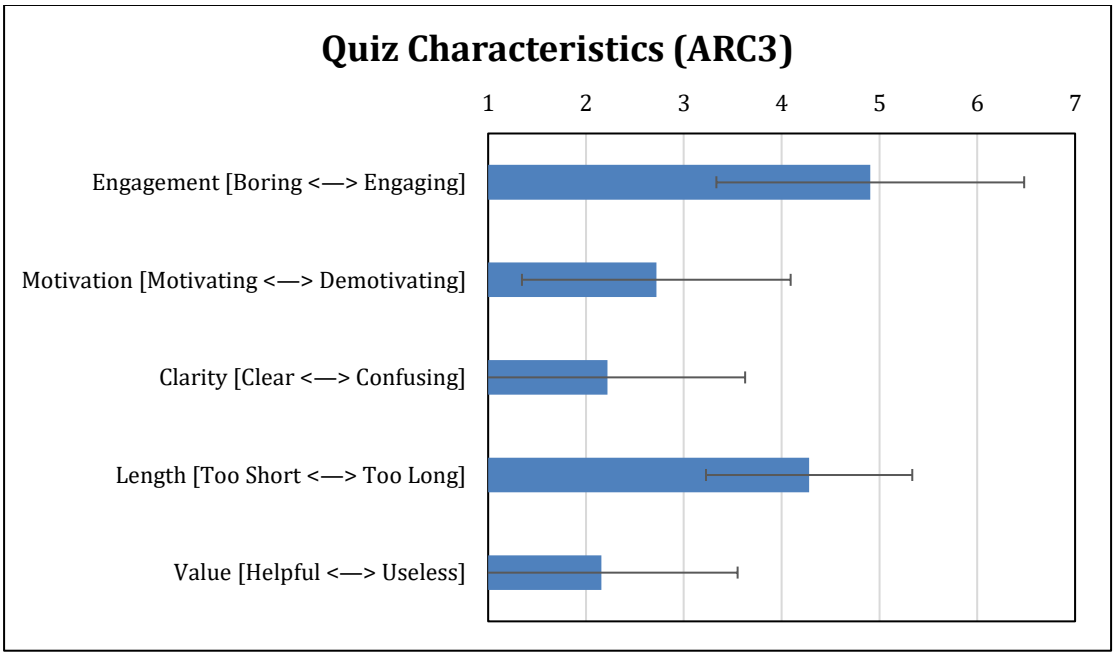


Figure 44. Quiz Characteristics (Moodle) [ARC3 End of Semester Survey]
Note: Scores indicate averages on a 7-point Likert-type scale. Error bars indicate ±1 SD

In this third action research cycle (ARC3), end of semester survey findings based on a 7-point Likert-type scale have provided further insights into the usability and educational value of the quizzes.

The engagement level of the quizzes was generally perceived as positive, with an average score of 4.91 and a standard deviation of 1.57. A majority of 56% of students found the quizzes engaging, surpassing the 19% who deemed them boring, while a quarter of the respondents remained neutral.

When assessing motivation, the quizzes were rated with an average of 2.72, and the standard deviation was 1.37. The majority of students, at 81%, found the quizzes to be motivating, contrasting sharply with the small fraction (6%) who found them demotivating. A neutral stance was held by 13% of students.

Clarity was one of the strong points, as indicated by the average score of 2.22 and a standard deviation of 1.41. The clear majority of students, 88%, found the quizzes clear, with only 9% indicating they were confusing. Neutrality was minimal here at 3%.

In terms of length, the average score was 4.28 with a standard deviation of 1.05, revealing some diversity in perceptions. While 28% of students felt the quizzes were overly long, a smaller percentage (9%) thought they were too short, and the most significant proportion (63%) provided no strong feedback, which could suggest contentment with the length.

Lastly, the quizzes' helpfulness garnered an average score of 2.16, with a standard deviation of 1.39. Students largely recognised the quizzes as beneficial, with 84% affirming their helpfulness. A minority of 9% disagreed, perceiving the quizzes as useless, and a small group of 6% remained neutral.

Overall, ARC3's survey results reflect a favourable view of the quizzes, highlighting their role in engaging and motivating students, providing clarity in learning content, and being helpful, although there is room for consideration regarding the optimal length of the quizzes. These findings reveal a generally favourable reception of the quizzes, continuing positive trends from previous cycles while demonstrating notable gains in certain areas. Engagement stands at an average of 4.91—an improvement over the mid-semester average of 4.12 and a continuation of the upward momentum noted in ARC2. Motivation is also strong: 81% of students reported being motivated by the quizzes, surpassing the mid-semester figure (54%) and echoing the higher motivational ratings seen in ARC2. Clarity remains a clear strength, with 88% finding the quizzes

understandable, building on the improvements established in earlier cycles. Although 28% of respondents still consider the quizzes too long, the majority remain neutral or satisfied, suggesting that length-related concerns are diminishing compared to ARC1's more pronounced critiques. Helpfulness stands at 84%, closely aligning with the consistently high marks this dimension has received since ARC1 and reinforcing the quizzes' perceived value. Overall, these results confirm that the ARC3 quiz refinements have successfully maintained and, in some cases, enhanced the positive elements identified in previous cycles, while leaving room for continued fine-tuning of quiz length and complexity.

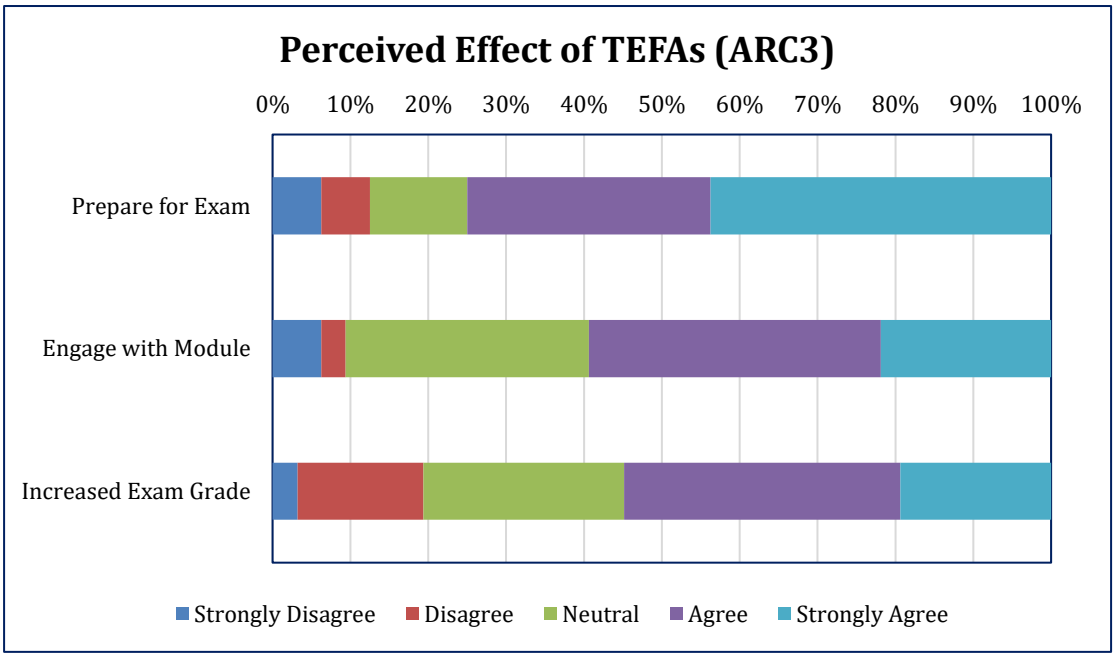


Figure 45. Perceived Effect of TEFAs on Exam Preparation, Engagement, and Grades [ARC3 End of Semester Survey]

Figure 45 illustrates how students evaluated the impact of TEFAs on their exam preparation, engagement with module materials, and exam grades, providing a detailed picture of the perceived effectiveness of the TEFAs.

For the statement "Prepare for Exam," the overall agreement is high, with 75% of respondents either agreeing or strongly agreeing that TEFAs helped with exam preparation. Notably, the "Strongly Agree" option had the highest individual count (14), suggesting that a substantial number of students found a strong correlation between TEFA completion and exam readiness. The combined number for both "Agree" and "Strongly Agree" far outweighs the neutral and disagreeing responses, indicating that a significant proportion of students view TEFAs as a key part of their exam preparation.

In relation to “Engage with Module,” the data shows that 59% of respondents agreed or strongly agreed that TEFAs enhanced their engagement with the module. However, the responses were more spread across the “Agree” and “Strongly Agree” options (12 and 7, respectively) compared to the exam preparation statement. This distribution suggests varying degrees of perceived engagement, with some students feeling more strongly about the TEFAs’ impact than others. A notable 31% remained neutral, indicating that a third of the participants were either unsure of the TEFAs’ impact on their engagement or did not see a direct link between TEFAs and their level of involvement in the module.

The responses to “Increased Exam Grade” displayed a broader range of opinions. While 55% of respondents agreed or strongly agreed that TEFAs helped improve their exam grades, this was the only category where the combined “Neutral” and “Disagree” or “Strongly Disagree” responses (45%) nearly equalled the positive responses. This suggests that the relationship between TEFAs and improved exam performance may be influenced by a more complex set of factors, or students may have found it harder to see a direct connection between completing TEFAs and achieving higher exam grades.

Compared to previous cycles, these results demonstrate a continued positive perception of TEFAs, with outcomes generally surpassing ARC1 yet not reaching the peaks observed in ARC2. In particular, exam preparation scores show a marked improvement over ARC1’s mid-range figures but fall short of ARC2’s near-unanimous endorsement. Engagement levels mirror ARC1’s moderate results and likewise are below the stronger engagement seen in ARC2. Lastly, although a higher proportion of students perceived TEFAs as boosting their exam grades than in ARC1, these numbers remain slightly lower than ARC2’s. Overall, the ARC3 data confirm that TEFAs maintain their value in supporting exam readiness and engagement, though the heightened momentum of ARC2 did not entirely carry through to the final cycle.

Responses to the Open-Ended Survey Questions

As explained in the mid-semester survey findings for this cycle, the end-of-semester survey findings are also presented separately for students who engaged with the quizzes and those who did not. This approach allows for a more detailed exploration of the factors influencing both engagement and non-engagement in this third cycle of the research.

Non-Engagement with Quizzes

Student reasons for not engaging with online quizzes revealed challenges and preferences within their academic experience. This section explores the factors influencing students' decisions to opt out of this learning tool, from time management and strategic postponement to personal apprehensions and balancing work, life, and study.

1. Deferred Engagement

A common strategy reported by students was to delay their engagement with the quizzes until a time closer to the exams. This approach, however, often resulted in non-completion, as one student admitted they "*never got around to doing so*."

2. Questioning the Value

For some students, there was scepticism about the quizzes' utility in their study methods. One student expressed doubt about the relevance of the quizzes for their revision, opting instead for study methods they considered to be more directly beneficial, such as "*sample exam questions*."

3. Anxiety and Confidence Issues

The fear of poor performance and the subsequent emotional impact was a deterrent for some. This group included students who were apprehensive about the quizzes amplifying their sense of underachievement, with sentiments like "*didn't wanna be de-motivated,*" coming to the forefront.

4. Time Management

Time was a critical factor, with students feeling overwhelmed by their academic and personal schedules. This was succinctly put by a student who felt they simply "*didn't have time left,*" to dedicate to optional quizzes.

5. Perception of Module Difficulty

The challenge posed by the module's content itself led to avoidance behaviour. Some students chose not to expose themselves to potential failure in a public setting, even an anonymous one, due to the module's perceived difficulty.

6. Preference for Traditional Study Methods

Some students preferred more traditional methods of revision. One student explained that they used the quizzes passively, by reviewing the questions and then working out the answers separately on paper. This indicated a preference for physically writing out

answers, suggesting that these students may have found more benefit from a hands-on approach rather than engaging directly with the online quizzes.

7. Prioritisation of Graded Assessments

With the high stakes of graded assignments and exams looming, students prioritised these over the ungraded quizzes. Other comments reported that the choice to focus on assessments that directly impact their grades was a strategic one for managing their academic workload.

8. Technical and Environmental Constraints

Issues such as lack of internet access at home meant that some students could only engage with digital resources while on campus, which added another layer of time management challenges.

9. Motivation

Motivation levels varied, with some students citing a lack of it as their reason for not engaging. Statements like "*Wasn't bothered,*" and "*Lazy,*" are indicative of the broader challenge of self-motivation with unsupervised, self-directed learning activities like quizzes.

10. Work and Life Balance

Balancing work, personal responsibilities, and academic work was a significant barrier. Students who worked on weekends or had early morning commitments found it difficult to allocate time for quizzes, as one student's situation of "*work weekends so time constraint is a huge problem for me,*" illustrates.

Engagement with Quizzes

Students who chose to engage with online quizzes provided feedback in the end of semester survey that reflected their experiences, indicating a generally positive reception towards this learning tool. Their responses highlighted the quizzes' role in their study routines and the perceived benefits for exam preparation. The survey data from students who completed the online quizzes this semester painted a largely positive picture of their experiences. In this section, we examined the range of constructive feedback provided by these students, who have highlighted the quizzes as a significant aid in their academic journey. Positive aspects such as the immediate feedback, the relevance of content to upcoming exams, and the variety in question types, students have expressed how these quizzes have favourably impacted their study routines and exam preparedness. While they have offered suggestions for improvements, these are

framed as enhancements rather than criticisms, underscoring the overall beneficial nature of the quizzes. This positive reception is indicative of the quizzes' potential as a valuable learning tool, which, with some refinements, could become an even more effective component of the educational offerings.

1. Immediate and Constructive Feedback

A prominent feature that many students found helpful was the immediate feedback provided by the quizzes. Being able to see the correct answers at the end of a quiz allowed students to promptly gauge their understanding of the material. As one student put it, "*Feedback + correct answers given when a Q was wrong*," encapsulated the utility of quizzes in offering real-time learning opportunities.

2. Relevance to Exam Preparation

The quizzes were seen as closely aligned with the exam content, which students appreciated for guiding their revision. The presence of sample exam questions and essay-style questions seemed to offer a preview of what to expect in the exams, with one respondent noting, "*They were helpful*." Another mentioned, "*Long questions at the end helpful for exam revision*," highlighting the practicality of quizzes in preparing for formal assessments.

3. Variety and Depth of Questions

The mix of question types, ranging from multiple-choice to long, essay-style questions, was another aspect that students found beneficial. This variety not only catered to different learning approaches but also provided a comprehensive review of the topics. A student's response, "*Short Questions. Long questions at the end helpful for exam revision*," illustrated how the blend of question types can cater to the breadth and depth of subject understanding.

4. Content Understanding and Application

For some students, quizzes served as a tool to apply theoretical knowledge in a practical format. As one student reflected, "*It was nice to be able to attempt essay-type questions and have feedback given*." Other comments mentioned the real-life context of the essay questions and how this application of knowledge helped in solidifying content comprehension and provided a clear indication of the level of detail required for their exam answers.

5. Strategic Use in Study Routines

Several students indicated they used quizzes strategically as part of their study routine. For example, one student mentioned using the quizzes "*after I had done my own revision to make sure I was on the right track*," suggesting quizzes are not just for immediate learning but as a check-in point within a larger revision strategy.

6. Clarity and Understanding of Material

Students' appreciation for the quizzes' clarity was emphasised in their feedback, with one noting the advantage of "*Seeing the options available for each answer*." Others commented on how the clear presentation of quizzes helped simplify their decision-making and their learning. The constructive criticism regarding language use, with a student suggesting a "*lighter,*" language approach, spoke to the need for quizzes to be not only clear but also accessible in their wording, catering to a broader range of comprehension levels.

7. Constructive Suggestions for Improvement

The feedback included actionable suggestions for refining the quizzes. Students identified specific areas for enhancement, such as a request for "*more examples of E-R diagram,*" to support understanding in more technical sections. Additionally, clarity in instructions was a recurring theme, with a student recommending, "*Maybe with the longer questions with no multiple choice, mention how many words minimum*," which reflects a desire for more guidance on expectations. These insights are valuable to fine-tune quiz content, ensuring it is both informative and intuitive for students across various subjects.

Observational Notes and Addressing the Gap

The third action research cycle was focused on building upon the feedback and data collected from the previous two cycles, with a particular emphasis on refining quiz design and enhancing student motivation. As discussed, these improvements were driven by multiple data sources, including student feedback, lecturer observations, quiz analytics, and a review of relevant literature.

I was conscious that this research was rooted in the principles of assessment for learning and assessment as learning. The experience gained from cycles 1 and 2 provided valuable insights that had already facilitated continuous improvement across Quizzes 1-9 during the previous year.

Despite my clear objectives, many of my notes reported how I faced significant time constraints during this semester. Not only was I carrying out this research, but I was also acting as Head of Department, which was not a teaching role. Nonetheless, I noted that I wanted to maintain my teaching hours with this group to continue my research.

Quiz Design and Redesign

For this cycle, I introduced a new quiz for Topic 1, bringing the total to five quizzes. Creating this new quiz from scratch required substantial preparation time to ensure alignment with the learning objectives and to maintain consistency with the existing quiz format. This process involved designing questions that both challenged students and reinforced key concepts, while also considering factors like clarity, length, and relevance.

In addition to creating the new quiz, I undertook a comprehensive review of the four quizzes developed in the first cycle. While this redesign process was less time-intensive than the initial creation phase, it still required a detailed analysis of each quiz to identify areas for improvement. I reviewed all questions and answers alongside student performance data from ARC1, which provided valuable insights into question clarity, difficulty levels, and engagement. Based on these observations, I adjusted or removed questions as needed to improve each quiz's overall effectiveness. To enhance accessibility and encourage participation, I made a deliberate effort to streamline the quizzes by reducing the question counts: Quiz 2 was shortened from 41 to 20 questions, Quiz 3 from 34 to 17, Quiz 4 from 18 to 16, and Quiz 5 from 22 to 14. This reduction aimed to address the time pressure students reported and to make the quizzes more manageable, ultimately supporting higher engagement levels.

Engagement and Participation

To improve quiz participation, I removed the chapter summaries that contained quiz questions and answers, a practice I had already implemented in the second cycle but needed to reapply when the Moodle data were rolled over to this cycle. Additionally, I collaborated with a lecturer who conducted the lab element of the class to dedicate some lab time to quiz attempts. However, due to their time constraints, this was only possible once over the semester.

Detailed Improvements and Adjustments

Updating a quiz from a previous cycle involved significant time, effort, and a meticulous approach to ensure the assessment activities were effective and aligned with

the learning objectives. To illustrate the extent of this effort, I detail below the process of updating Quiz 3, which started with Quiz 2 data from the previous cycle.

The first step was to gather all relevant quiz data from the first research cycle, including each student's attempt, time taken, individual scores, and overall results. This data set provided insights into question performance, student trends, and areas requiring improvement. To facilitate analysis, I calculated the total scores for each question across all attempts, allowing me to identify patterns in student responses.

I then focused on highlighting questions with unusually high or low scores. For example, if a question had a perfect success rate or a very high score, it might indicate that the question was too easy or that the content had been thoroughly covered in class. Conversely, if a question had consistently low scores, it might suggest ambiguity, misalignment with course material, or insufficient coverage during lectures.

With the data analysis completed, I began reviewing each question to determine which ones required rewriting or reordering. Questions with ambiguous phrasing, unclear language, or that did not align with learning objectives were candidates for revision. I aimed to ensure each question was straightforward, relevant, and appropriately challenging.

During this phase, I deleted questions that were redundant or did not contribute to the quiz's objectives. This process involved striking a balance between maintaining a reasonable question count and ensuring comprehensive coverage of the course material. In some cases, I reworded questions to remove confusion or to better align with the terminology used in lectures.

To further refine the quiz, I implemented a colour-coding scheme for questions based on their difficulty level. Low-scoring questions were marked in red, medium-scoring in yellow, and high-scoring in green. This visual representation helped me identify questions that needed additional attention, either through rewording or reordering.

Additionally, I reviewed the quiz to eliminate any repetition of questions or content, ensuring a smooth flow and logical progression. I also made minor adjustments, such as correcting spelling errors (e.g., changing "z" to "s" where appropriate) and removing less valuable closed questions to create space for more open-ended essay questions.

Beyond individual questions, I considered the quiz's overall structure and layout. This included reordering questions to match the flow of class content and placing more open-

ended questions at the end. By doing so, I aimed to guide students through a logical progression while encouraging deeper reflection toward the quiz's conclusion.

I also adjusted the text box sizes for certain questions, reducing them from 20 lines to 10 or 15 lines. This adjustment aimed to mitigate the daunting effect of large text boxes, making essay-type questions more approachable with the intention of not compromising the expected response quality.

Once the revisions were made, I piloted the quiz by attempting it myself. This step allowed me to experience the quiz from a student's perspective, ensuring that the changes improved the user experience without introducing new issues. During this phase, I verified that each question adhered to the desired difficulty level, had clear instructions, and was free from grammatical errors.

I also re-checked the constructive alignment of each question with the learning outcomes and the final exam content. This step ensured that the quiz remained focused on relevant material and contributed to the overall course objectives.

Through this detailed and comprehensive process, I ensured that the updated quiz met the high standards expected for effective assessment, contributing to the overall success of the research cycle. This process had to be done for the other three quizzes and one new one had to be designed from scratch. There was a considerable amount of work involved, as will be discussed in the next chapter in the context of the demands on the teachers to create quizzes.

Mid-Intervention Surveys and Student Feedback

As reported earlier, I distributed paper-based mid-intervention surveys in class and logged the data for further analysis. The preliminary findings helped me implement changes for the remaining quizzes of this cycle.

Initial findings from these surveys revealed several important insights. Some students cited time, laziness, and perceived lack of value as reasons for not attempting quizzes, while those who did attempt them found the essay questions difficult. This indicated a potential need to provide more guidance on word count expectations for essay questions. I also asked about their perception of the quizzes' impact on motivation, engagement with module content, and exam preparation. The goal was to trigger metacognition and encourage students to see the connection between their quiz performance and their exam results.

Interestingly, the survey results highlighted contradictions. Some students mentioned that the quiz standard was fairly easy, yet they rated their performance as low. This inconsistency suggested a need for further exploration to understand the underlying reasons for the perceived gap between quiz difficulty and student performance.

Conclusions from this Cycle

Engagement and Participation in Quizzes

A significant theme across ARC3 was the varied level of student engagement with quizzes. There were many reasons reported for non-engagement, including time constraints, prioritisation of compulsory coursework, digital access issues, and personal study preferences. On the other hand, those who engaged with quizzes valued their use for revision, exam preparation, and the immediate feedback they offered.

Quiz Characteristics and Student Perceptions

Survey results showed how students perceived various aspects of quizzes. These aspects included mental demand, performance, engagement, motivation, clarity, length, usefulness, and innovation. Students found the quizzes somewhat demanding but beneficial for learning. There was a moderate positive response regarding engagement, with a majority finding the quizzes motivating and clear. The length of quizzes was an area of divided opinion, with some finding them too long. Overall, the quizzes were considered helpful, and a majority perceived them as innovative.

Impact on Learning and Exam Preparation

Students generally acknowledged the positive impact of quizzes on their exam preparation and engagement with module materials. A high percentage agreed that quizzes helped in preparing for exams and engaging with the course material. However, opinions were more divided on the direct impact of quizzes on exam grades, with a significant portion of students remaining neutral or unsure about this relationship.

Challenges and Preferences in Non-Engagement

Among those who did not engage with the quizzes, several challenges and preferences influenced their decision. Time constraints due to academic workload, perceived utility, digital access issues, personal study habits, and motivation were key factors. Some students also prioritised graded coursework over optional quizzes. Additionally, external commitments and a balance between work, life, and study played a role in their ability to engage with the quizzes.

Positive Engagement and Utility of Quizzes

For students who engaged with the quizzes, they served as valuable tools for revision, assessing understanding, and preparing for exams. They appreciated the variety in question types and the immediate feedback provided. The quizzes were seen as an effective means of applying theoretical knowledge and as a strategic tool within broader study routines.

Suggestions for Improvement

Feedback from students also highlighted areas for improvement in quiz design and implementation. These suggestions included providing more examples for technical sections, clearer instructions, especially for longer, open-ended questions, and possibly adjusting the quiz length to better sustain student interest and engagement. There was a call for more guidance on expectations for answers, indicating a need for precise instructions to aid students in providing adequately detailed responses. Some students also recommended making the language used in quizzes lighter and more accessible, catering to a broader range of comprehension levels.

Overall, the ARC3 provided insights into student engagement with quizzes, their perceptions of quiz characteristics, and the impact of quizzes on learning and exam preparation. While there was general positivity towards the quizzes, especially in their role in aiding study and providing immediate feedback, there were notable areas for improvement. Addressing challenges related to non-engagement and refining quiz design based on student feedback could further enhance the effectiveness of quizzes as a learning tool. These insights provide valuable guidance for future iterations of quiz-based learning interventions, with a focus on optimizing engagement, clarity, and the educational value of quizzes to meet diverse student needs and preferences.

5.4. Summary of Key Findings

Across the three action research cycles, several key findings emerged that provide valuable insights into the role of TEFAs in student engagement and learning. These findings highlight both the effectiveness and the challenges of integrating TEFAs into a higher education context. They can be grouped into three overarching themes: student engagement patterns, the impact of TEFAs on learning and motivation, and the challenges of implementation and design.

Engagement with TEFAs followed distinct patterns. Most students used the quizzes strategically for exam revision rather than engaging with them consistently throughout

the semester. LMS data revealed that participation was highest in the weeks and days leading up to exams and significantly lower during the rest of the semester. While various interventions, such as adjusting quiz timing and providing reminders, led to modest improvements, particularly in ARC3, maintaining consistent engagement across the semester remained a challenge. Focus group and survey responses reinforced this, with students viewing quizzes as supplementary rather than integral learning components.

TEFAs also played a role in shaping students' learning strategies and motivation. Many students reported that the quizzes helped them identify gaps in their understanding and guided their revision, with the immediate feedback proving particularly valuable. However, while students perceived the quizzes as beneficial, quantitative analysis revealed only a limited correlation between quiz participation and improved exam results. This suggests that while TEFAs contributed to a sense of them feeling prepared for the exam, their direct impact on performance was more difficult to quantify. Motivation also emerged as a complex factor, with some students engaging with quizzes due to their interactive nature, while others expressed that they would have participated more if the quizzes carried assessment marks. These findings highlight the balance between intrinsic and extrinsic motivators in shaping student engagement with formative assessments.

Finally, the iterative refinement of TEFAs across the three cycles also revealed important insights into their design and implementation. Student feedback highlighted key considerations such as the length, clarity, and format of quizzes, with most preferring shorter, more structured assessments with instant feedback, while others valued open-ended questions and detailed feedback (see Appendix G: Samples of Grading and Feedback), even if it took longer. Accessibility also played a role in engagement, as some students faced technical difficulties or preferred traditional study methods. The process of embedding TEFAs effectively within the module required careful alignment with course content and workload demands. This ensured the TEFAs complemented rather than competed with other academic priorities. While modifications were made throughout the research to improve usability and encourage participation, sustaining engagement remained an ongoing challenge, highlighting the need for further exploration of how best to integrate formative assessments into students' learning routines.

These overarching themes form the basis for the Chapter 6: Discussion chapter, where the implications of these findings will be examined in relation to the existing literature and the theoretical framework developed for this study. The discussion will explore the effectiveness of TEFAs in fostering engagement and learning, the challenges associated with embedding them into academic practices, and their potential role in shaping future formative assessment strategies in higher education.

Chapter 6: Discussion

This chapter interprets and discusses the findings, explicitly guided by the synthesised theoretical framework developed in Chapter 3. Section 6.1 opens the chapter by situating the findings within this framework, clearly demonstrating the alignment between empirical data and the theoretical constructs of Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK). Section 6.2 then expands on these findings through a detailed thematic exploration, critically engaging with the key themes of student engagement, learning dynamics, and assessment design optimisation. Throughout, the iterative nature of action research is emphasised, illustrating how cycles of reflection and adaptation both shaped the interventions and deepened the understanding of TEFAs' roles in higher education. The chapter concludes in Section 6.3 by explicitly articulating the theoretical contribution and practical significance of the synthesised framework, emphasising its capacity to clarify complex educational realities.

Lastly, the chapter critically engages with how these findings connect with the broader literature, reflecting on how the study's framework can inform future teaching practices and further research. Rather than drawing final conclusions here, the implications for teaching practice and policy development are further elaborated in Chapter 7.

6.1. Interpretation of Findings: Alignment with the Theoretical Framework

The findings of this study offer significant insights into the dynamics of TEFAs, viewed through the lens of the customised framework developed specifically for this research (see Figure 4). As explained in Chapter 3, this customised framework integrates the principles of Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2009) into a unified structure, designed to balance pedagogical, technological, and assessment practices to foster both student engagement and learning outcomes. The alignment between the findings in Chapter 5 and this theoretical framework reinforces its validity while also providing practical insights for its application.

The foundational layer of the synthesised framework illustrates the interplay between content, pedagogy, and technology, ensuring that assessments not only engage with content but also support dynamic, interactive learning environments. The findings from

this study revealed that TEFAs, such as bespoke quizzes, delivered this balance, supporting both content delivery and pedagogical goals. This aligns with existing literature, which emphasises the role of technology in enhancing student engagement and enabling more dynamic assessment environments (Gikandi et al., 2011). For instance, the bespoke quizzes used in the study were not only technologically advanced, but also pedagogically sound, promoting both interaction and inclusivity in the learning environment. This supports Carless's (2007) "double duty" of assessment as both evaluative and educative. However, contrasting viewpoints in the literature suggest that while technology can support pedagogical objectives, it may also introduce complications, such as increased cognitive load for students (Sweller, 2020), and difficulties in effectively aligning technology use with pedagogical outcomes (Whitworth & Wright, 2015). These contrasting perspectives highlight that while the framework offers a theoretical foundation, its practical application may require careful balancing to avoid unintended consequences.

The middle layers of the customised framework focus on integrating formative assessment practices, specifically Assessment for Learning (AfL) and Assessment as Learning (AaL), supported by continuous feedback. The findings demonstrate that the immediate and personalised feedback provided through TEFAs facilitated ongoing learning and self-regulation. This aligns with the broader literature on formative assessment, where timely feedback is identified as a key mechanism for enhancing students' capacity to regulate their learning (Nicol & MacFarlane-Dick, 2006). In this study, students also reported that the feedback helped them identify areas of weakness and adjust their study strategies accordingly, reflecting the LOA principle of promoting learning through assessment. This finding supports Whitworth and Wright's (2015) assertion that formative assessments offering real-time feedback can motivate students by allowing them to adjust their learning in a more self-directed manner.

Furthermore, the findings revealed that engaging with TEFAs significantly boosted students' confidence and preparation for summative assessments. Although there was no significant correlation between quiz participation and improved exam results, students indicated that the TEFAs helped them feel more prepared for exams, particularly by reinforcing their understanding of key concepts. This aligns with Carless and Boud (2018), who argued that formative assessments, by providing timely and actionable feedback, enhance students' readiness for exams and contribute to more

effective revision strategies. They assert that even when immediate summative gains are not observed, such assessments reinforce students' learning by offering regular checkpoints and promoting continuous engagement with course material. Black (2015) similarly emphasised that while the direct summative impact of formative assessment may not always be evident, its true value lies in fostering a deeper understanding and sustained engagement. He noted that formative assessments contribute to long-term learning gains by promoting reflection, self-assessment, and iterative improvement. These findings of this study reinforce the framework's emphasis on the formative role of TEFAs, which aims to enhance learning through continuous feedback and reflection, even if such improvements do not always translate directly into higher grades.

The top layer of my framework, which focuses on broader learning outcomes such as content mastery and the development of self-regulated learners, is well-supported by the findings, though it invites further exploration. Students participating in the study who consistently engaged with TEFAs demonstrated improved understanding and retention of course material, which they attributed to the immediate feedback provided by TEFAs. They said that this feedback encouraged them to actively reflect on their learning and adjust their study strategies accordingly. For example, several students mentioned that the TEFAs helped them to monitor their progress and identify areas for improvement, which fostered a sense of ownership over their learning. This aligns with the framework's goal of promoting self-regulated learning, a critical component of lifelong learning. Additionally, some students reported that engaging with TEFAs developed their critical thinking skills by requiring them to engage more deeply with the material, although the evidence for this was more anecdotal and would benefit from further investigation. While the TEFAs provided opportunities for reflection and self-assessment, not all students consistently reported the development of these higher order thinking skills, suggesting that the relationship between formative assessment and critical thinking may be more complex than initially anticipated. This aligns with Black's (2015) observation that formative assessments can foster deeper engagement, but the extent to which they contribute to critical thinking development may depend on the specific design and implementation of the assessments.

The findings of this research also highlight the need to consider the diversity in students' responses to TEFAs. While many students benefited from the TEFAs, some even shifted their study approach by engaging with the module content earlier and more

consistently. Others primarily used them as revision tools, which, although helpful for exam preparation, did not necessarily foster deeper or more continuous engagement throughout the semester. This suggests that while the framework's goal of fostering self-regulated learners is valid, the path to achieving this may not be uniform for all students. Future research could investigate the long-term development of critical thinking and self-regulated learning, particularly in relation to how different students engage with these assessments and the varying outcomes they experience.

Finally, this study's customised framework, developed specifically to integrate LOA and TPACK, emerges as a potential contribution to the field. The findings demonstrate its potential as a practical tool for designing, implementing, and evaluating TEFAs. By merging the pedagogical and technological considerations, this framework has the potential to provide educators with a structured approach to enhancing both engagement and learning outcomes in higher education.

6.2. Discussion of Thematic Findings

This section identifies three main themes that emerged from the research: the challenge of student engagement, the dynamics of student learning, and the optimisation of assessment design. While the discussion around each theme is presented in separate sections below, all the themes are very much interconnected.

6.2.1. The Challenge of Student Engagement

The impact of technology-enhanced formative assessment on student engagement is a pivotal aspect of this study, with the findings providing valuable insights into how students engage with learning materials over the course of their studies.

Student Participation and Interaction through TEFAs

This section examines how student engagement, participation, and interaction were influenced by the use of TEFAs. In the first action research cycle (ARC1), a comparison group was included to assess whether the TEFAs had an impact on student engagement. Interestingly, engagement statistics for students using TEFAs were no higher than those in the comparison group. Although this was ARC1 and further enhancements of the TEFAs happened over the next two research cycles, this is still a finding that challenges expectations from the literature. Previous research suggested that TEFAs typically boost student participation (Krishnan, 2023). This discrepancy might reflect differences in implementation, contextual factors, or the evolving nature of educational technology,

which necessitates a deeper understanding of how students engage with such tools. Although earlier research, like Gikandi et al. (2011), emphasised the role of TEFAs in increasing engagement, Krishnan (2023) found that student participation was strongly influenced by extrinsic factors such as assessment deadlines rather than intrinsic motivations. The next paragraph explores potential reasons for this divergence, including the cyclic patterns of student activity and study habits.

Analysis of LMS data revealed several key trends. Students predominantly engaged with the material leading up to exams, with significant drops in activity during holidays such as bank holidays and term breaks. This cyclic pattern was consistent across both the control and research groups, suggesting that engagement levels were more reflective of general study habits rather than specific responses to the TEFAs. This aligns with Vicente et al.'s (2021) study on academic behaviour, which demonstrated that students often exhibit procrastination and just-in-time learning approaches, where engagement peaks in the lead-up to assessments.

The iterative nature of action research allowed for adaptive strategies to be introduced to improve student engagement. By ARC3, engagement levels had improved throughout the semester, with LMS activity increasing by approximately 15% compared with ARC1, a change attributed to several modifications, such as altering quiz timing and providing more tailored feedback. These changes are examined in more detail in the sections below, providing a clearer picture of the incremental adjustments that contributed to this shift in student behaviour.

The LMS data also showed a positive correlation between increased LMS usage and the number of quiz attempts. This correlation suggests that students who were more engaged with the LMS were also more likely to participate in the TEFAs. However, this activity remained concentrated towards the end of the semester, reinforcing the notion that students used TEFAs as a revision tool rather than for continuous learning. The role of interactive elements, such as immediate feedback, also contributed to sustaining engagement. Interactive TEFAs, which provided real-time feedback and self-assessment opportunities, were shown to maintain student attention more effectively than traditional study methods. These interactive components align with Blondeel et al.'s (2022) assertion that formative assessments offering immediate feedback can motivate students by allowing them to adjust their learning strategies in real-time. Additionally, Henderson et al. (2019) emphasised that timely, specific feedback is

crucial for helping students to close the gap between their current performance and desired learning outcomes. However, Winstone and Boud, (2022) argued that these benefits were still limited by students' broader study habits, which continued to focus on exam preparation rather than sustained engagement throughout the semester.

Qualitative data further challenged initial assumptions that TEFAs would lead to continuous, self-motivated engagement. Initially, it was believed, based on existing research (e.g., Shepard et al., 2018; Leenknecht et al., 2021), that students would be intrinsically motivated to continue using TEFAs if they recognised their value. However, the data showed that many students did not engage with TEFAs beyond their initial attempts. Instead, the majority used TEFAs primarily for revision purposes, rather than as part of a continuous learning process. This divergence from expected continuous engagement is particularly relevant when viewed through the lens of the synthesised LOA-TPACK framework used in this study. LOA emphasises ongoing formative assessment and feedback as a driver of student learning (Carless, 2007), and TPACK highlights the critical alignment of technology, pedagogy, and content knowledge (Koehler & Mishra, 2009). However, despite these theoretical ideals, students in this study clearly prioritised assessments based on extrinsic motivations tied to grades and deadlines, reinforcing the complexity of applying theoretical models in real educational settings. Further analysis revealed that students preferred to complete other study-related tasks before attempting the TEFAs, suggesting that they viewed TEFAs as a secondary tool, used strategically for revision rather than integrated into regular study habits. While I had expected to see more continuous engagement with course material, this consistent finding still highlights the value of TEFAs in supporting targeted revision and exam preparation. Winstone and Carless (2020) noted that students' engagement with formative assessments often hinges on perceived relevance to summative outcomes, aligning with the findings from this current study. Factors influencing this included time constraints, competing academic priorities, and cognitive load. This reflects other research, such as Maier et al.'s (2016) study, which suggested that extrinsic motivators, such as grades and exam preparation, often dominate students' engagement decisions.

These insights suggest that we should reevaluate of the role of TEFAs in maintaining continuous engagement with module content. While TEFAs have proven effective as revision tools, their ability to encourage regular, self-motivated interaction appears to

remain limited. In line with these patterns of revision-focused usage and extrinsic motivators, Winstone and Carless (2020) noted that enhancing student participation through formative assessments requires a deeper understanding of student study habits, intrinsic and extrinsic motivators, and the balance between assessment formats and learning objectives.

Enhanced Motivation and Interest

Shepard et al. (2018) point out that motivation and interest are critical factors in student engagement and that the integration of TEFAs has been shown to significantly influence these areas. Broadbent (2021) also conclude that well-designed formative assessments, particularly when integrated with technology, can act as powerful motivators, fostering both intrinsic and extrinsic motivation. Previous studies (Dobson, 2008; Einig, 2013, McCallum & Milner, 2021) have noted that integrating online quizzes into coursework can enhance student engagement and motivation, with real-time feedback playing a crucial role in this process. Similarly, the findings reported in Chapter 5 found that quizzes were particularly effective in boosting students' motivation during revision, as they provided a means of tracking progress and reinforcing learning. However, as the focus here moves from discussing engagement to motivation and interest, it is essential to clarify the role of TEFAs in sustaining student motivation throughout the course.

Data from this current study suggest that students used TEFAs strategically, particularly as a means of tracking their progress during revision periods. This finding validates a key component of the synthesised framework used in this study, which emphasises that aligning technology integration (TPACK) with formative assessment strategies (LOA) can sustain motivation and interest throughout the learning experience (Carless, 2007; Koehler and Mishra, 2009). Several students noted that the TEFAs allowed them to monitor their understanding and prepare more effectively for exams. In the focus groups, students described how they leveraged the TEFAs to reinforce their revision, aligning their use with their individual learning styles or learning approaches. These findings indicate that TEFAs can cater to a range of student preferences, a critical element reflected in the integrated framework.

The findings of this current study show that participants consistently highlighted that timely and personalised feedback from TEFAs helped maintain their motivation. This immediacy allows students to understand their mistakes quickly and correct them, aligning closely with LOA's emphasis on formative feedback (Carless, 2007). The

broader literature also supports this conclusion. For instance, Gikandi et al. (2011), found that personalised feedback can significantly enhance students' learning experiences by helping them identify areas for improvement. This is particularly motivating for learners who seek continuous feedback (Granberg et al., 2021). Nicol and MacFarlane-Dick (2006) further emphasised that ongoing feedback supports self-regulation, enabling students to adjust their learning strategies based on immediate results, which can sustain motivation and deepen engagement. While TEFAs offer substantial potential in this area, the accessibility and flexibility of these tools emerged as a critical consideration in this current study. For example, several students noted difficulties accessing quizzes on smartphones through Moodle, which affected their access to the content and hindered their consistent engagement. This barrier demonstrates the importance of ongoing refinement in technological practices highlighted by the TPACK framework. At the time, this was also due to Moodle's lack of compatibility with mobile devices or "mobile friendliness." This challenge aligns with Bennett et al. (2017), who argue that assessments must be optimised for multiple devices to encourage regular use. Balancing the provision of timely, personalised feedback with accessible technology, therefore, appears essential for leveraging TEFAs to enhance both the intrinsic and extrinsic motivation of a diverse student body.

Despite the advantages of these digital tools, their impact is not guaranteed. It is clear from this current study that educators must carefully design and implement TEFAs to ensure they meet the needs of diverse learners while balancing intrinsic and extrinsic motivation. While extrinsic motivators, such as grades, can drive participation, the synthesised framework emphasises that such motivators should not overshadow the formative purposes and intrinsic learning benefits central to LOA (Carless, 2007). The findings reinforce the importance of an integrated approach, combining technological clarity and pedagogical insight, to create engaging, motivating educational environments that support both immediate and long-term learning outcomes.

Self-Regulated Learning

The findings from this present study also highlight the important role that TEFAs played in fostering self-regulated learning (SRL) among students. SRL involves students actively managing their learning by setting goals, monitoring progress, and adjusting strategies (Marín et al., 2020). The findings from this study show that TEFAs provided an interactive, feedback-rich environment where students could self-assess their

understanding and reflect on their progress, which is consistent with literature emphasising the role of self-assessment in fostering learner autonomy and independence (Clark, 2012; Andrade, 2019). Through the online quizzes, students were able to track their learning, identify areas for improvement, and adjust their study approaches, both key components of self-regulated learning. The students reported that this process helped build a sense of ownership over their learning and promoted continuous improvement.

While the data did not explicitly indicate that students engaged in structured or formal reflective practices (e.g., using reflective journals or frameworks), their behaviours suggest informal reflection as part of their study process. Many students reported using quizzes to plan their revision and adjust their focus based on the feedback received. For instance, one student noted, *"Using quizzes helped me become more disciplined in my studies. I started to plan my revision better and felt more in control of my learning."* Thes types of informal reflections align with the literature on self-regulated learning, which emphasises the role of feedback in promoting reflection and adjustment of learning strategies (Marín et al., 2020). The evidence from this study suggests that in the act of reviewing quiz feedback, the students engaged in a process of evaluation, analysis, and planning. Therefore, as part of this, the TEFAs helped facilitate reflective thought and adaptive learning.

The transition from transactional to transformational learning further illustrates the depth of student engagement with the TEFAs. Transactional learning typically involves students completing tasks to fulfil basic academic requirements, often without deep engagement or meaningful change in understanding. In contrast, transformational learning involves a more profound shift in perspective, where students begin to see learning as a continuous process of growth and development. Mezirow's (1991) theory of transformative learning explained how such shifts often arise from reflective practices and engagement with disorienting dilemmas, which challenge prior assumptions and encourage new meaning-making. In this study, the TEFAs supported this shift by providing opportunities for students to receive immediate feedback, reflect on their progress, and make strategic adjustments to their learning approaches. Knight and Yorke (2003) argued that formative assessment helps students understand the standards expected of them, driving them towards higher levels of achievement and self-improvement. Similarly, Eschenbacher and Fleming (2020) concluded that

transformative learning requires an active interplay between reflection and new experiences, both of which were facilitated by the TEFAs in this study.

Findings from this study support the idea that TEFAs can act as a catalyst for this type of transformation. Students reported using TEFAs to identify gaps in their knowledge and focus their efforts on areas needing improvement. This strategic use of TEFAs aligns with Granberg et al. (2021), who suggested that TEFAs promote self-regulated learning by providing timely feedback and fostering learner autonomy. Similarly, Blondeel et al. (2022) emphasised that immediate feedback allows students to adjust their learning strategies promptly, leading to better academic outcomes. The current findings demonstrate that, for many students, the TEFAs facilitated a transition from transactional to transformational learning by encouraging deeper reflection and more active participation in the learning process. Ultimately, it appears that the TEFAs served as tools for revision and also acted as vehicles for deeper engagement. The findings have reinforced the arguments that by integrating TEFAs that offer real-time feedback and self-assessment opportunities, educators can foster environments where students are encouraged to take control of their learning, promoting both transactional and transformational learning experiences. The emergence of self-regulated learning behaviours aligns strongly with the AaL dimension of the customised theoretical framework, confirming that formative assessments, when combined with immediate feedback and opportunities for reflection, foster learner autonomy (Earl, 2003). Nevertheless, the inconsistent development of higher-order thinking skills also reveals that the practical application of this theoretical aspiration is context-dependent.

Time Management and Academic Prioritisation

A recurring theme in the qualitative data was students struggling to find time for TEFAs due to their heavy academic workload. This finding shows the importance of designing TEFAs to be time-efficient and treated with the same importance as other academic tasks. Many students expressed difficulty balancing their various academic responsibilities, highlighting the competition for time in their busy schedules. For example, some students in focus groups reported feeling overwhelmed when TEFAs coincided with other assessments or deadlines, making it challenging to engage with them as intended. Whitelock et al. (2015) emphasised that a misalignment between workload expectations and the realities of students' schedules can negatively impact engagement and satisfaction. Similarly, Nguyen, et al. (2018) pointed out that students

often engage with learning materials at times that suit their individual needs, underscoring the necessity for flexibility in quiz timing. Therefore, based on the study's findings, any additional academic activity, such as quizzes, must be carefully timed and not overly demanding from both a time and cognitive perspective to fit into students' schedules. This aligns with the principle that formative assessments should be integrated seamlessly into the learning process, rather than seen as add-ons, to avoid overburdening students (Nicol & MacFarlane-Dick, 2006).

The challenge of fitting TEFAs into students' already busy schedules was evident from the current research. Some students reported feeling overwhelmed by the frequency and timing of TEFAs, which sometimes conflicted with their preparation for other assessments or deadlines. This indicates that the design and scheduling of TEFAs need careful consideration to ensure they complement, rather than compete with other academic tasks. For instance, short and focused TEFAs might be more easily incorporated into students' routines, minimising the additional time burden. Moreover, Nguyen, et al. (2018) noted that even minor adjustments to the timing and format of tasks can encourage greater engagement, particularly among students who struggle to allocate consistent time to academic activities. These findings support the idea that flexible, well-paced assessments can alleviate workload pressures. This also reflects the practical application of the theoretical framework, where the integration of LOA and TPACK emphasises the importance of aligning pedagogical intent with technological design to ensure assessments are not only effective but also manageable within students' academic routines.

Effective formative assessments can help students identify knowledge gaps early, allowing them to allocate their study time more efficiently (Carless, 2007). By helping students focus their efforts where needed most, TEFAs can improve overall academic performance and reduce last-minute cramming. The study findings reported in the previous chapter suggest that TEFAs need to be perceived as valuable and integral parts of the learning process to ensure students prioritise them. It follows, then, that clear communication from educators about the purpose and benefits of TEFAs, aligning them with course objectives and other assessments, is essential to ensure students see them as beneficial and worth their time. Whitelock et al. (2015) argued that clear communication about workload expectations is integral to fostering student buy-in, particularly when balancing formative assessments with other academic demands. This

aligns with the findings of Nguyen, et al. (2018), who suggested that aligning assessments with students' natural study rhythms can lead to more effective engagement.

Strategic Design and Embedding of TEFAs

The integration of TEFAs into the curriculum requires a strategic approach to ensure they support learning effectively and foster student engagement. In this current study, the iterative action research process facilitated the thoughtful planning and refinement of quiz design and implementation, ensuring alignment with learning objectives and addressing student needs identified in earlier cycles. For instance, the TEFAs were designed with a clear pedagogical focus: balancing cognitive challenge and accessibility while encouraging deeper learning. This strategic approach incorporated diverse question types, such as multiple-choice questions for immediate feedback and essay-style questions to promote critical thinking and reflective practice. TEFAs were embedded at regular intervals throughout the module to provide continuous opportunities for self-assessment, enabling students to monitor their progress and adapt their study strategies accordingly. This approach reflects the middle layer of the theoretical framework, which integrates LOA's emphasis on formative feedback and student agency with TPACK's focus on aligning technological tools with pedagogical intent and content relevance.

A key component of this strategy was embedding TEFAs in a way that clearly demonstrated their relevance to students' broader academic goals. This involved aligning quiz content with key course objectives and using them as diagnostic tools to highlight areas needing further development. Analysing the LMS data was essential here to see how students were performing. Over the cycles, adjustments aimed to enhance student motivation and engagement by refining the content and format in response to feedback. This approach reflects Bearman et al.'s (2023) emphasis on assessment design fostering critical engagement and reflection while remaining flexible to accommodate diverse learner needs. Similarly, Heil and Ifenthaler (2023) emphasised the importance of integrating formative and summative elements to ensure assessments support both immediate learning objectives and long-term academic success.

The findings revealed that this deliberate, strategic embedding of TEFAs yielded positive outcomes in several key areas. Students consistently reported that the structured

placement of TEFAs throughout the module helped them develop a clearer understanding of their progress, enhancing their confidence during exam preparation. Additionally, the alignment of quiz content with course objectives enabled more targeted learning, as students could focus their efforts on areas of weakness identified through feedback. These results align with research suggesting that well-designed, pedagogically grounded assessment tools significantly enhance student motivation and engagement (Bearman et al., 2023). However, challenges related to timing and workload balance emerged as critical factors influencing the success of this approach. As earlier findings indicated, some students experienced difficulty incorporating TEFAs into their study routines, particularly during peak academic periods. These insights highlight the importance of ongoing refinement in quiz scheduling and format to ensure they complement, rather than compete with, other academic tasks. Incorporating student feedback into these adjustments reflects the iterative nature of the study's action research methodology, ensuring that formative assessment design remains responsive to learner needs and contextual realities. Another challenge relating to this is the amount of time and it took me to prepare the TEFAs and, as best I could, strategically embed them into the module in a timely manner. This is discussed further the Challenges for Educators section in Chapter 7.

Enhancing Engagement through Accessibility

The research showed that the integration of interactive quizzes and real-time feedback mechanisms notably increased student participation and engagement in learning activities. This finding aligns with research by the National Forum for the Enhancement of Teaching and Learning (NFETL, 2015), which highlights how technology can enhance the adaptability, immediacy, and personalisation of assessments. Studies such as Gikandi et al. (2011) further suggest that technological tools provide an opportunity to cater to a wide range of student preferences, making assessments more inclusive. However, it is essential to avoid over-reliance on a single perspective, as several studies indicate the importance of considering digital equity and accessibility challenges when designing technology-enhanced assessments (Bennett, 2011; Granberg et al., 2021).

Digital accessibility remains a central issue in ensuring that all students can fully engage with technology enhancing learning (TEL) tools. While technology offers flexibility by allowing students to access materials and assessments at their own pace and from different locations, accessibility barriers such as inconsistent internet access or varying

levels of digital literacy can hinder student participation. Roberts and Foehr (2008) highlight the ways in which the digital divide persists along socioeconomic lines, particularly in relation to access to computers and the Internet, which remains strongly linked to students' backgrounds. This divide means that some students, particularly those from lower-income households, are less able to engage fully with digital tools. One student in this study mentioned, *"I don't have wifi at home, so I'd have to do it in college,"* emphasising the need to address these barriers to ensure equitable access to learning tools.

Furthermore, the findings indicate that varying levels of digital literacy among students require the design of user-friendly tools and the provision of adequate technical support. This is consistent with recent studies advocating for more advanced technical infrastructures and support systems in educational settings (e.g. Blondeel et al., 2022). The findings show the need for continuous communication and support is particularly crucial, as students benefit most from TEFAs when they are confident in their ability to navigate these systems. Research on technology acceptance models as far back as Davis (1989) also highlighted the importance of perceived ease of use and usefulness in influencing users' attitudes and behaviours towards technology.

In recognising these challenges, it is clear that there is a need to prioritise digital equity in the implementation of TEFAs. Ensuring that all students have the resources needed to engage fully, whether through providing devices, offering internet access, or developing alternative formats for those facing technological barriers, is a critical consideration. This aligns with the broader literature on the persistence of the digital divide, which emphasises the need to address socioeconomic disparities in access to technology to create truly inclusive learning environments (Roberts & Foehr, 2008).

Incentivisation

Incentivisation emerged as a critical theme for me in understanding student engagement with formative assessments, particularly in the context of online quizzes. Insights from focus groups and open-ended survey responses highlighted various factors influencing student motivation and the potential role of incentives in enhancing participation. While the ratings on quiz characteristics and the perceived value students reported from engaging with them was very positive in the second and third cycles, they still showed some uncertainty. For example, even where a notable portion of students found the TEFAs motivating and helpful, others remained more neutral. This variability coupled

with the student feedback outlined below, both from those who engaged and did not engage with the TEFAs, suggests that some form of incentivisation could play a role in increasing engagement. The literature supports this view, indicating that well-designed incentives can significantly enhance student participation in formative assessments (e.g., Carless, 2007). More recently, Chevalier et al. (2018), for example, highlight that even small stakes attached to assessments can substantially increase participation, particularly for students with lower prior engagement levels.

A frequently expressed sentiment by students in this current study was the desire for TEFAs to contribute towards their grades, even if the contribution was minimal. Several students believed that the prospect of earning marks would significantly encourage more engagement. As one student put it, "*A reward maybe for a continuous assessment, add marks for attempting the quizzes."* Another student reinforced this idea, stating, *"Definitely. People would definitely take up on that if they knew they were getting marks."* This sentiment was echoed by many, indicating that even a small allocation of marks could influence student behaviour: *"Even if it was only a small amount of marks."* Similar findings were reported by Agnew et al. (2021), who observed that removing even minor incentives caused a sharp decline in student engagement and participation quality. However, as discussed in the Strategic Design and Embedding of TEFAs section, a deliberate decision was made not to allocate marks in this study to preserve the formative nature of the quizzes. This decision reflects the prioritisation of feedback and self-assessment opportunities over extrinsic motivators. While awarding marks may have increased participation, it could have shifted the TEFAs towards a summative function, potentially diminishing their formative value.

Additionally, feedback from students who did engage with the TEFAs revealed that ongoing encouragement and promotional efforts were crucial. While initial high levels of encouragement led to strong engagement, this waned as the semester progressed and promotional efforts diminished. This highlights the importance of consistent incentivisation and motivational strategies throughout the academic term to sustain engagement levels. Kibble (2007) suggested that formative assessments are most effective when supported by regular reinforcement strategies that maintain student focus and motivation. Similarly, Gikandi et al. (2011) and Agnew et al. (2021) emphasised that extrinsic motivators, when used strategically, can sustain engagement without undermining the formative purpose of assessments. These findings underline

the need for institutions to adopt a balanced approach to incentivisation, integrating elements of both extrinsic rewards and intrinsic motivators to foster sustained participation and meaningful engagement with learning tools.

6.2.2. Dynamics of Student Learning

The interplay between student perceptions of learning and the measurable impact of formative assessments was a focal point of this study. Initially, my focus leaned heavily on quantitative data analysis, driven by an expectation that clear correlations between quiz participation and exam performance would emerge. However, as the research progressed, the qualitative data provided a much richer and better understanding of students' experience. This shift highlighted the interpretive nature of the action research methodology, which allowed for a deeper exploration of the complexity of measuring the learning benefits of TEFA alongside students' perceptions of success. This section examines these dynamics, emphasising the discrepancy between perceived and measurable outcomes.

Measuring Learning Benefits v Student Perception of the Benefits

One of the key challenges identified in this research is quantifying and measuring the impact of TEFAs, such as quizzes, on student learning outcomes. Despite the implementation of these assessments to support deeper learning, the findings indicated little to no direct correlation between quiz attempts and improved exam results. This raises questions about the role of TEFAs in fostering understanding that endures beyond exams between perceived and actual benefits. While students often reported feeling better prepared for exams, the extent to which this learning translated into long-term retention or application of knowledge remains unclear and warrants further investigation.

The literature on TEFA shows mixed results regarding its measurable impact on academic performance. While formative assessments, particularly in digital formats, are designed to provide ongoing feedback and support adaptive learning, quantifying their direct effect on exam results remains challenging. Bennett (2011) pointed out the difficulty of isolating the impact of formative assessments, particularly the factors that influence the outcomes. Similarly, research by Zawacki-Richter et al. (2019) suggests that while TEFAs can improve short-term understanding and confidence, their role in promoting deeper, transferable learning requires a more longitudinal study to fully understand their impact.

Selwyn's (2008) "State of the Actual" concept adds another layer of complexity by highlighting how educational technologies, including TEFA, often fall short of their theoretical potential when applied in real-world settings. This perspective is particularly relevant when considering the limited measurable impact of TEFAs on summative exam results. It stresses the need to critically evaluate how TEFA tools are implemented and the contextual factors that influence their effectiveness.

Survey data collected from students revealed a perceived benefit in terms of exam preparation and expected grade improvements. Many students reported that quizzes helped them feel more prepared and confident. However, despite these positive perceptions, actual exam results did not consistently support this belief. Analysis of correlation data from ARC1-3 revealed no significant relationship between the frequency of quiz attempts and final exam scores, suggesting that the perceived benefits of TEFA did not consistently translate into measurable academic performance.

Student Perceptions of Success

Understanding how students define success is crucial for evaluating the effectiveness of TEFA. Carless (2015a) describes how many students continue to equate success with exam results and grades, which can obscure the broader benefits of formative assessments, such as improved understanding, knowledge retention, and the development of self-regulated learning skills. While students may value the immediate feedback provided by technology-enhanced quizzes, the deeper educational benefits are apparently not always fully appreciated.

The discrepancy between student perceptions and actual measurable outcomes raises critical questions about how success is defined and assessed in educational contexts. Black and Wiliam's (1998, 1999, 2019) research concluded that formative assessment plays an essential role in learning, but its benefits are often qualitative and process-oriented rather than quantitative. This aligns with the findings of this study, where students acknowledged the value of TEFAs for ongoing learning, yet primarily judged their success based on exam performance. However, it is important to note that while quiz participation did not appear to significantly influence exam results, this does not imply that students who engaged with TEFAs derived no benefit. Without a control mechanism to measure what their performance would have been without the TEFAs, it is not possible to discount their contribution to other aspects of learning, such as confidence and engagement.

As alluded to above, the correlation data from ARC1-3 further underline the complexity of measuring learning benefits. While students reported positive experiences with TEFA, the data showed no strong correlation between quiz participation and exam results. This suggests that while TEFAs may foster engagement and provide timely feedback, their direct impact on summative assessments remains unclear. Factors such as study habits, prior knowledge, and intrinsic motivation likely influence exam performance, complicating the attribution of success solely to TEFA. This analysis highlights the need for a broader and more in-depth understanding of success in education, one that values both formative and summative achievements and recognises the complex nature of learning. By addressing these challenges, educators can design and implement TEFA in ways that support both immediate learning goals and long-term academic success, while acknowledging the limitations and strengths of both qualitative and quantitative measures. This discrepancy between perceived and measurable benefits provides an important test of the theoretical framework's assumption that formative assessments inherently lead to improved learning outcomes. Although TEFAs supported student confidence and perceived preparedness, the absence of clear quantitative correlations challenges simplistic interpretations of the LOA and TPACK models in real-world settings.

Learning Preferences and Study Habits

The diversity in students' learning preferences and study habits or approaches presents a significant challenge for educators aiming to implement effective formative assessments. Nancekivell et al. (2020) reported that while the concept of "learning styles", the belief that individuals learn best when taught according to their preferred mode of information presentation, gained considerable influence in education in the 20th century, it has been widely discredited in more recent studies. Pashler et al. (2009) argued that despite its popularity, there is insufficient empirical evidence to support the idea that tailoring instruction to specific learning approaches enhances educational outcomes. Their review found little evidence for the so-called "meshing hypothesis," which suggests that students learn better when instructional methods match their purported learning approach. Instead, the focus has shifted towards recognising learning preferences, which are more fluid and context dependent. Students may prefer certain study methods for particular subjects or tasks, but these preferences do not indicate fixed styles of learning. Tomlinson (2014) has reinforced the importance of

differentiated instruction in addressing the diverse needs of students. She advocated for a flexible approach that adapts teaching strategies based on students' readiness levels, interests, and varying needs, rather than adhering to a one-size-fits-all model based on learning approaches.

Students' resistance to adopting new digital tools often reflects comfort with familiar methods and scepticism about the effectiveness of technology in learning. Jordan (2009) noted that while online assessments can provide immediate feedback, they may be perceived as overly complex, or impersonal by students who are less confident with technology. This aligns with findings by Winstone and Nash (2016), who emphasised that students' engagement with feedback depends significantly on their ability to process and act upon it. They suggested that providing explicit strategies for interpreting and using feedback can bridge gaps in students' assessment literacy and foster a more effective engagement with digital tools. This sentiment was echoed in this study, where many students cited their past success with traditional methods, exemplified by the comment, *"If it's not broken, why fix it?"*

Strategic Utilisation of TEFAs

A strategic approach to TEFAs involves using them to focus on specific topics, reinforce understanding, and identify areas that require further study. The findings revealed that students often employed TEFAs as targeted learning tools, integrating them into their broader study plans to enhance their exam preparation. Research on formative assessments supports this strategy, and Gikandi et al. (2011) noted that TEFAs offer timely feedback that helps students focus their efforts where it is needed most. This aligns with the literature on assessment for learning, which highlights the role of TEFAs in helping students gauge their comprehension and retention of key concepts (e.g., Nicol & MacFarlane-Dick, 2006). Studies have shown that regular, low-stakes assessments, such as TEFAs, can significantly improve students' readiness for summative exams by promoting active recall and boosting their confidence in their knowledge (Carless and Boud, 2018). Additionally, the diagnostic function of TEFAs helps students identify knowledge gaps early, allowing them to target their revision efforts more effectively (Jordan, 2009).

The flexibility and convenience of online quizzes reportedly made them an attractive option for students, allowing them to integrate formative assessments into their study routines at their own pace. Research suggests that this autonomy fosters a more

personalised learning experience, as students can engage with the material on their own terms (Looney, 2019). By combining quizzes with other study methods, such as note-taking and group discussions, students felt better prepared and more confident for exams, as quizzes helped consolidate their understanding and reinforce key concepts.

Students' strategic use of TEFAs reflects the path posited by the theoretical framework as a direction that learners might take to achieve focused, reflective study habits (Carless, 2007; Koehler and Mishra, 2009). However, variations in student uptake also illustrate that effective application of this theory must account for learner diversity and contextual factors.

This current study revealed the potential of TEFAs as effective tools for academic success, particularly for students who use them strategically to focus on specific topics, prepare for exams, and identify knowledge gaps. However, finding about their impact on performance was inconclusive and may vary among students, reinforcing the need for flexible and diverse approaches to formative assessment. Their convenience and adaptability make TEFAs a valuable component of modern study routines, supporting personalised learning and encouraging deeper engagement with the material.

Fostering a Feedback Culture

One of the most significant findings from this current research was the role of immediate, personalised feedback provided by the assessment technologies. Over half of the students expressed that such feedback enabled them to understand their learning progress in real-time, which empowered them to take control of their learning journey. This empowerment through feedback aligns closely with the synthesised theoretical framework used in this study, particularly LOA's emphasis on feedback as a central tool for supporting student autonomy and self-regulated learning. This immediate feedback helped students identify their strengths and weaknesses and adjust their learning accordingly. As Heitink et al. (2016, p. 50) emphasised, high-quality feedback must be "substantial, constructive, and focused" to effectively guide learning and improve student outcomes.

The integration of technology into formative assessments can positively impact student engagement across several dimensions, as suggested by both the findings of this study and the literature. Technology can act as a catalyst for increasing participation, enhancing motivation, and improving learning outcomes through immediate feedback (Morris et al., 2021). Those scholars reported that these aspects are crucial not only for

maintaining student engagement but also for encouraging active participation in their learning processes. These principles are explicitly reinforced in the TPACK component of the integrated framework, which underscores the importance of aligning technology effectively with pedagogical strategies and content knowledge (Koehler & Mishra, 2009). Additionally, Landl and Wylie (2024) highlighted the importance of cultivating an assessment culture where students perceive feedback as a collaborative process that empowers them to take meaningful action towards improvement. They concluded that implementing technology-enhanced assessments that provide immediate, constructive feedback can significantly aid student learning. From the findings in this study, it is evident that using platforms, in this instance Moodle and Learnosity, that allow for quick feedback on student assessments and encouraging students to act on this feedback is beneficial. However, as Shepard, et al., (2018) cautioned, feedback alone is not sufficient. It must be actionable and provide students with specific, meaningful insights that facilitate deeper engagement with the learning material.

As evidenced in the findings chapter, the speed of feedback is a critical component of effective formative assessment. Rapid feedback, even when provided manually for essay-style questions, can significantly enhance the learning experience. Students noted that they benefitted from timely insights into their performance, allowing them to make immediate adjustments to their learning strategies. This immediacy helped maintain their engagement and motivation, as they saw the direct impact of their efforts and understood where improvements are needed. As Yorke (2003) noted, the quality of feedback, i.e., its specificity, constructiveness, and timeliness, plays a transformative role in the learning process, making it more dynamic and responsive to students' needs.

Perceived Understanding and Confidence in Learning

The data collected for this study revealed a marked improvement in students' perceived understanding and confidence in their grasp of course material when technology-enhanced assessments were used. While this did not necessarily result in significantly higher exam results, students reported feeling more confident about their knowledge, suggesting that the assessments played an important role in their learning experience.

This increase in confidence can be attributed to the engaging nature of the assessments, which required students to actively apply, analyse, and evaluate the material. The participants stated that assessments encouraged reflection on their learning, fostering a sense of mastery, even if this was not fully reflected in exam performance. Yorke (2001)

noted that such active engagement facilitates the processing of information, helping students better encode and retrieve what they have learned.

The results of the current research showed that another factor contributing to this perceived confidence was the provision of model answers and detailed feedback on essay-type questions. Students noted that they found these tools particularly useful for improving their approach to answering questions and structuring responses. The detailed feedback highlighted areas for improvement while reinforcing strengths, helping students understand how to enhance their performance over time. This iterative process of attempting tasks, receiving feedback, and reflecting on their performance fostered greater confidence, even though exam scores may not fully have reflected this improvement.

Additionally, technology-enhanced assessments allowed for frequent testing and repetition, which reinforced learning and contributed to long-term retention. Regular TEFAs and practice tests provided students with opportunities to revisit material and monitor their progress. This continuous reinforcement, as Sweller (2020) suggested, helps consolidate learning in long-term memory. As reported in the findings, the ability to regularly review material and address persistent challenges further contributed to students' confidence in their understanding.

Balancing Automated and Manual Feedback for Individual Learning

This study found that while students appreciated the instant feedback from automatically graded multiple-choice questions, they particularly valued the more detailed, personalised feedback on essay-type questions, even though it took longer to receive. This observation aligns with Carless and Boud's (2018) argument that individualised feedback can be highly effective in addressing specific learning needs. Although the immediacy of automated feedback is efficient, students in this study noted that tailored, in-depth feedback (provided through the online platform, thus qualifying as technology-enhanced) helped them more fully understand their weaknesses and improve over time.

However, delivering such manual, essay-based feedback took considerably more instructional time than automatically graded quizzes. This was a trade-off that I found acceptable as long as students were engaging and benefiting from it. These findings corroborate Jordan's (2009) point that automated systems (like multiple-choice quizzes) can offer quick responses that help learners adjust strategies immediately, but risk

promoting only surface-level engagement. While short TEFAs played a valuable role in keeping students involved, participants ultimately preferred the deeper, more reflective learning experience that emerged from instructor-led, essay-style feedback.

The mix of question types proved important in sustaining engagement. If all questions required lengthy essay responses, the substantial time required for grading could reduce efficiency and potentially deter student participation. Conversely, relying solely on automatically graded items might inadvertently encourage more superficial learning. Therefore, achieving a balance, i.e., offering both quick-response quizzes and occasional, more demanding essay tasks, appears to best serve students' diverse needs.

A new development since this study is the growing use of AI-driven feedback tools. Although AI was not examined explicitly here, these emerging technologies show promise in blending the speed of automated assessments with the kind of personalisation typically available only through manual feedback. As Zawacki-Richter et al. (2019) and Rahiman and Kodikal (2024) suggest, AI may soon deliver more nuanced feedback at scale, potentially replicating or even improving on the benefits of manual essay feedback. This view aligns with Looney's (2019) perspective that digital assessments can enhance real-time feedback and support personalised learning. The implications and future research directions for these developments will be discussed further in the Section 7.5.3 in Chapter 7.

Cultural Hurdles in a Traditional Educational Sector

As mentioned in the opening chapter, transitioning from secondary level to higher education in Ireland involves overcoming cultural hurdles, particularly the entrenched emphasis on summative assessments (Fisher, Cavanagh & Bowles, 2011; JISC, 2016; Vanstone & Hicks, 2019). The comments shared by participants in the present study showed that this experience in their early schooling had shaped students' study methods and attitudes towards learning, making it challenging to shift towards a formative assessment approach in higher education. The emphasis in the Irish system is on high-stakes exams, such as the Junior Certificate and Leaving Certificate, which significantly influence students' academic futures. This system fosters a culture where the primary value is placed on exam results rather than the learning process itself. Consequently, students develop study habits that prioritise rote memorisation and short-term learning goals aimed at excelling in exams. As one student mentioned, *"I've always done my*

studies this way, so won't be changing," reflecting a deep-rooted reliance on traditional study methods.

When these students enter higher education, where formative assessments are more prevalent, the shift in expectations can be challenging. This cultural shift also highlights the practical complexities of applying theoretical frameworks such as the synthesised LOA-TPACK model, which emphasises formative feedback and student-centred learning, in environments dominated by traditional summative approaches. Formative assessments are designed to provide ongoing feedback and foster deeper learning, but they often clash with students' ingrained focus on summative outcomes. This misalignment presents challenges not just for students but also for educators seeking to promote more meaningful learning processes. Yorke (2003, p. 477) articulated this challenge, noting that while the value of formative assessment is recognised in higher education, it is not always fully understood or embraced. He suggests that both students and educators may undervalue formative assessments, seeing them primarily as mechanisms to improve summative exam performance rather than as tools to enhance deep learning. This perspective can diminish the broader educational benefits of formative assessments, especially if they are viewed solely through the lens of their immediate impact on grades.

The long-standing emphasis on summative assessments cannot be easily undone. By the time students in Ireland reach higher education, they have spent approximately 14 years in a system that reinforces these habits. As Dempsey (2016) suggested, addressing these ingrained patterns requires more than simply motivating students to engage with formative assessments; it also involves confronting the long-term influence of their prior learning experiences. Constructive alignment (Biggs, 1996) between assessments, learning outcomes, and teaching activities can help bridge this gap, but if this alignment continues to prioritise grades over genuine learning, such as really understanding and being able to apply knowledge, then students may remain trapped in surface learning strategies.

6.2.3. Optimising Assessment Design

The findings of this study indicate that iterative design across multiple cycles, utilising various data sources, is an effective method for developing assessments. Participant feedback plays a crucial role in this process, as it informs adjustments and ensures assessments meet the diverse needs of students. In this section, two key approaches to

optimising assessment design are explored: quiz design and structure, and collaborative design.

Quiz Design and Structure

The design and structure of quizzes play a crucial role in their effectiveness as formative assessment tools (Murphy et al., 2023). Student feedback revealed mixed opinions on quiz design, indicating the need for a balanced approach that considers diverse preferences and learning needs. This section will explore key aspects of quiz design, including quiz length and question formats, a reflection on the focus of quiz design, and the comparison between bespoke quizzes and off-the-shelf content.

Quiz Length and Question Formats

Students' opinions on quiz length varied. While some found longer quizzes acceptable, the majority preferred shorter, more concise formats. This aligns with findings from (Carless, 2015b), who emphasised that assessment design should prioritise accessibility and clarity to enhance student engagement. Students in the study expressed a preference for quizzes that are manageable in length, engaging, and not overly time-consuming. This feedback suggests that TEFAs should be designed to strike a balance between being comprehensive enough to cover essential material and concise enough to maintain student engagement. This is consistent with Nicol's (2021) emphasis on reducing the cognitive demands of assessments to promote self-regulated learning.

Concise question formats and moderate difficulty levels were also favoured. Students appreciated questions that were clear and easy to understand, allowing them to demonstrate their knowledge without unnecessary complexity. One student commented, *"Shorter quizzes with straightforward questions help me stay focused and engaged."* While "straightforward" in this context may refer to clarity and ease of understanding, it does not necessarily preclude a level of challenge. Research suggests that even seemingly simple questions can require complex cognitive processes, such as critical thinking, analysis, and application of knowledge (Bloom et al., 1971).

In reflecting on quiz engagement, it may be useful to explore the connection between lower attention spans and student preferences for shorter, more concise TEFAs. Research indicates a general decline in attention span, potentially influenced by digital device use and social media, which promotes rapid, fragmented content interactions (Carr, 2010; Duke & Montag, 2017). This shift may affect students' ability to sustain focus in longer assessments, reinforcing the importance of tailoring quiz length to

maintain engagement. Redesigning TEFAs into smaller, focused elements that align with students' learning goals could support retention and reduce cognitive load, positioning TEFAs as a more integral part of the learning process.

In reflecting on quiz engagement, research suggests that reducing attention spans and digital habits may influence preferences for shorter, more concise TEFAs. Wu and Jessop (2018) note that declining attention spans in digital learning environments can impact focus, while Higley (2016) highlights how digital devices and social media foster fragmented engagement. Designing shorter, focused TEFAs that align with these patterns may support retention and reduce cognitive load, enhancing their role in the learning process. These insights reinforce the theoretical assertion that assessment design must balance the use of accessible and supportive technologies with pedagogical effectiveness, a core principle within the TPACK and LOA synthesis. Thus, achieving optimal assessment design demands careful consideration of how technology facilitates pedagogical intentions without introducing additional cognitive burdens.

Reflection on Quiz Design Focus

Reflecting on the study's approach to quiz design, there may have been an overemphasis on the aesthetic and usability aspects in survey questions, possibly at the expense of focusing on the actual pedagogical value of the TEFAs. At the time, I thought that by perfecting the quiz design, the engagement levels would increase dramatically. However, students seemed to benefit most from elements like essay questions, model answers, and prompt feedback, suggesting that these components were more impactful than multiple-choice questions (MCQs), which some might have viewed as less critical. This observation aligns with Winstone and Carless's (2020) emphasis on the formative value of detailed and actionable feedback, as well as Carless and Boud's (2018) argument that feedback should focus on deepening understanding rather than merely assessing performance.

This finding raises questions about the relative importance of different quiz components. While MCQs can be useful for quick checks of understanding, they may not provide the depth of learning that essay questions and detailed feedback can offer. As one student noted, *"The essay questions and the feedback were the most helpful parts of the TEFAs. They really helped me understand the material better."* This preference is consistent with findings by Gordon, (2020) who advocates for assessments that promote higher-order thinking.

Bespoke TEFAs vs. Off-the-Shelf Content

Another key consideration is the distinction between bespoke TEFAs tailored to the specific module content and off-the-shelf TEFAs that may not align as closely with the course objectives. The bespoke TEFAs, which were specifically designed for the module, involved significant effort in terms of creating relevant and pedagogically sound questions. This process ensured that the TEFAs were directly aligned with the learning outcomes and course content, enhancing their effectiveness as formative assessment tools.

As my research shows, the creation of bespoke content required careful deliberation over question types and content, reflecting a purposeful specificity in the formative assessment strategy. This approach aligns with the principles of constructive alignment (Biggs, 1996), where assessments are designed to directly support the intended learning outcomes of the module. The effort invested in developing bespoke TEFAs is discussed further in the pedagogical reflections section below, highlighting the substantial time and resources required for this level of customisation.

Encourage Collaborative Design

One of the significant advantages observed in this study was that co-created assessments tended to be more aligned with students' interests and needs, potentially leading to more meaningful learning experiences. This strategy moves away from the traditional top-down approach, where assessments are designed solely by educators and then imposed on students. Instead, it encourages students to actively participate in the design process, making them co-creators of their learning journey (Pereira de Sousa, 2018). By actively participating in assessment design, students offer valuable insights on aspects such as question length, level of difficulty, and relevance of content, thereby shaping assessments that resonate more closely with their own learning contexts.

In this study, for instance, survey and focus group feedback from students played a key role in informing how quizzes were designed in subsequent cycles. Although students did not devise the questions themselves, their input on question types, topic emphasis, and perceived difficulty influenced the adjustments made to each new set of quizzes. Moreover, in-class activities allowed students to brainstorm potential essay questions for the final exam, which offered further insight into how they approach question formulation. While time constraints during the semester limited the extent of student involvement, incorporating at least some of their suggestions helped ensure the quizzes

were more engaging and aligned with their needs. Dancer and Kamvounias (2005) suggest that there is an even deeper form of co-creation where learners are directly involved in writing or refining assessment items, because it can foster enhanced subject-matter understanding, and the process of question design itself can trigger deeper cognitive engagement.

However, the findings show that while this collaborative process improved the quality and relevance of assessments, it did not necessarily boost overall quiz participation rates. This indicates that additional factors, such as student motivation, perceived value of the quizzes, and effective time management, still play critical roles in determining whether students engage consistently with formative assessments. Nonetheless, the finding showed that co-creation did contribute to students feeling more invested and less like passive recipients, reflecting a shift toward a broader educational philosophy that values student voice, autonomy and active participation.

Traditional assessment models typically position students as passive subjects of evaluation. In contrast, involving them in design decisions empowers learners to see how and why assessments are crafted, thereby enhancing transparency and ownership. This transition to collaborative design also aligns with contemporary theories of student-centred and self-regulated learning (Bose and Rengel, 2009; Clark, 2012). By valuing student contributions to the assessment framework, educators may encourage a deeper commitment to both the learning and evaluation process. Future research might examine the direct impact of student-generated questions on their engagement levels, comprehension and retention, particularly if educators can integrate student co-creation more systematically without compromising the time-consuming nature of administering timely formative assessments.

6.3. Conclusion

In this chapter, the theoretical framework outlined in Chapter 3 was positioned centrally to help interpret and explain the findings. Using the combined perspectives of Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK), the discussion clarified how technology-enhanced formative assessments (TEFAs) impacted student engagement and learning. Throughout the chapter, the theoretical framework provided a consistent lens, highlighting areas of alignment with the findings, while also revealing practical challenges that arose during implementation. This structured approach demonstrates the synthesised theoretical framework's critical

contribution to understanding and theorising the complex realities of educational technology integration. By integrating LOA and TPACK, the framework enabled a detailed interpretation of how formative assessment, feedback, and technology interact in real-world settings. While the framework captured key dynamics, such as the importance of feedback, student agency, and technological integration, it also revealed areas where theoretical ideals diverged from practical realities, such as inconsistent engagement and varied student responses. These insights underline the framework's strength in bridging theory and practice, while also highlighting the need for ongoing refinement in future applications.

This chapter has synthesised and interpreted the findings on the effects of TEFAs on student engagement and learning in higher education. The discussion has provided a comprehensive analysis of the impact of these assessments on various aspects of student engagement, including participation, motivation, self-regulated learning, and time management. It has also explored the dynamics of student learning, focusing on the measurable benefits versus students' perceptions of the benefits, learning preferences, and the strategic use of TEFAs. A key theme that emerged is the complexity of integrating TEFAs into educational practices. While students perceived quizzes as beneficial for exam preparation and confidence-building, the quantitative data did not consistently show a significant correlation between quiz attempts and improved exam results. This finding aligns with Selwyn's (2011) concept of the "State of the Actual," which highlights the disconnect between the theoretical potential of educational technologies and their real-world implementation. Such findings also challenge overly optimistic narratives around digital technology in higher education, reinforcing both international (Selwyn, 2015) and Irish (Cooney et al., 2023) research that cautions against viewing technology as a universally beneficial solution. The discussion also emphasised the importance of context and customisation in educational technology, suggesting that a one-size-fits-all approach is often insufficient. The strategic design and scheduling of TEFAs, along with the provision of immediate, actionable feedback, were highlighted as crucial factors in enhancing their effectiveness.

This chapter put a focus on the iterative learning and professional development inherent in the action research process. The process that I went through in designing, implementing, and refining the TEFAs required ongoing reflection, adaptation and self-improvement, impacting my growth as an educator. Experiences such as navigating quiz

design challenges, integrating student feedback, and balancing pedagogical and technological considerations deepened my understanding of how educational change involves both teacher and learner development. A more detailed discussion of these professional development insights and their implication is explored in the Conclusion chapter, particularly in Section 7.7, Reflections on Professional Growth and Education Change.

Finally, the insights gained from this study can be further grouped into three interrelated areas assessment design, meaningful engagement, and self-regulation. Each one sheds light on how TEFAs can be most effectively implemented.

Assessment Design

Effective assessment design emerged as a key factor in enhancing student learning and engagement in this study. The iterative refinement of assessments, informed by student feedback, aligned closely with learning objectives and student needs, reinforcing the value of interactive assessments. The findings showed that the use of varied question formats promoted higher levels of student interaction and deeper engagement with the material, supporting the conclusion that diverse assessment formats cater effectively to different learning approaches and cognitive levels. The study's assessment design process emphasised a balance between formative and summative assessments, with careful attention to question types and feedback mechanisms. Multiple-choice questions, short-answer questions, and application-based questions were strategically employed, with the aid of platforms like Learnosity, to create the types of interactive questions that kept students engaged and facilitated a dynamic assessment experience. Looking at it from the other side of the question-and-answer process, the data indicated that immediate and detailed feedback was a core component of the assessment design. This feedback helped students promptly identify and correct mistakes, thereby reinforcing their learning and boosting their confidence. Findings showed that the ability to attempt quizzes multiple times and receive feedback after each attempt encouraged a growth mindset. Crucially, this afforded students the opportunity to view mistakes as learning opportunities rather than failures. This approach was seen to contribute to a more positive attitude towards learning and improved overall academic performance.

Meaningful Engagement

The study revealed that the distinction between deep and surface engagement was significant. Initially, students engaged superficially to meet immediate academic requirements, such as completing quizzes to prepare for final exams. However, the aim of the quizzes was not solely to improve exam performance but also to foster regular engagement with module content. By providing consistent opportunities for interaction with the material throughout the term, the quizzes prompted students to develop a deeper connection to the subject matter. The shift towards more interactive, student-centred assessments led to more frequent and meaningful engagement, where students not only prepared for exams but also consolidated their understanding of the content on a more regular basis.

Self-Regulation and Independent Learning

In line with the study's objectives, it was discovered that the TEFAs played an important role in self-regulated learning, by allowing students to control their learning pace, to access resources as needed, and to receive timely, tailored feedback. This environment encouraged students to become proactive in their learning and to take responsibility for their outcomes with a view to developing essential lifelong learning skills. Importantly, these aspects of the learning process all occurred outside of classroom hours, where students engaged in independent study without direct supervision. The use of digital platforms enabled students to track their progress, set personal learning goals, and seek additional resources to support their learning. This self-directed approach fostered a sense of ownership over their learning journey and helped them to develop important skills such as time management, goal setting, and self-assessment. These outcomes reflect the elements of the theoretical framework, with its emphasis on both AfL and AaL, highlighting the capacity of well-designed TEFAs to nurture lifelong learning competencies.

Chapter 7: Conclusion

7.1. Overview of Study

This research explored the use of technology-enhanced formative assessments (TEFAs) within a business-related higher education module, investigating their influence on student engagement, self-regulated learning, and overall learning outcomes. The study adopted an action research approach, enabling a reflective cycle of design, implementation, and iterative refinement of digital assessment tools, all of which carefully aligned with pedagogical goals to maximise educational impact. As an educator without a formal background in educational studies, this process provided me with valuable insights into how technology can transform educational practices, particularly in enhancing both teaching and learning processes. The primary research questions focused on whether TEFAs could improve student engagement and learning outcomes, and how they could be effectively integrated into higher education curricula. Through this research, I developed a deeper understanding of how digital tools can be leveraged to support pedagogical goals and foster meaningful student engagement.

The sections that immediately follow tease out the broader significance of what was discussed in the previous chapter. Section 7.2 examines how the study's key research questions were explored. It highlights how immediate, targeted feedback helped students correct misunderstandings early, promoting sustained engagement throughout the module. The section also emphasises the challenges educators face in implementing these assessments and the strategies developed to mitigate these difficulties. Section 7.3 outlines the significance of the study, with a particular focus on the development of a customised framework for integrating TEFAs. This framework aligns with the principles of Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK), illustrating how digital tools can be employed to enhance learning outcomes while supporting educators' pedagogical practices. This synthesised framework makes a distinctive contribution to the existing literature by explicitly combining the pedagogical insights of LOA with the technological integration guidance of TPACK, addressing critical gaps identified in previous research.

The remaining sections look forwards to what actions can be implemented in the future. In Section 7.4, recommendations for educational practitioners are presented, addressing the cultural challenges in higher education, diverse learning preferences, and the need

for enhanced assessment literacy among both students and educators. The findings highlight the importance of institutional support, adequate resources, and the gradual introduction of digital tools to ensure accessibility and inclusivity in assessments.

The thesis goes on to include recommendations for future research in Section 7.5, where specific areas are identified for further exploration. These include the need to investigate the adaptability of TEFAs across different educational settings, to examine the role of feedback mechanisms, and to assess the long-term impact of these assessments on student learning outcomes. This section also highlights opportunities for research on the integration of artificial intelligence (AI) and adaptive learning technologies in TEFAs.

Section 7.6 offers policy recommendations based on the study's findings. It advocates for strategic investments in technological infrastructure, comprehensive professional development for educators, and policies that promote digital equity to ensure that all students benefit from the advancements in educational technology.

Finally, Section 7.7 reflects on the professional growth and educational change that I personally experienced throughout the research. The section acknowledges the dual focus of the study: enhancing student learning through the integration of TEFAs and the educator's professional development during the action research process. This reflective aspect of the research highlights the role of continuous professional development and institutional support in sustaining the successful adoption of digital tools in education.

7.2. Addressing the Research Questions and Key Themes in the Findings

It is important to reiterate that the action research approach allowed the research questions to evolve over the course of the study. While the first two research questions, focusing on student engagement and learning outcomes, were set from the outset, the third and fourth questions emerged as the research unfolded, reflecting new insights gained during the process. This evolution enabled a more comprehensive exploration of how TEFAs can influence various aspects of teaching and learning in higher education. The following sections summarise how each research question was answered through the findings, highlighting key themes and providing insights for educators and policymakers.

7.2.1. Influence on Student Engagement

Research Question: How do technology-enhanced formative assessments influence student engagement in a higher education setting?

The study revealed that technology-enhanced formative assessments had a notable influence on student engagement. Initially, engagement levels peaked around assessment deadlines, indicating a pattern of surface engagement driven by immediate academic requirements, in this case the final exam. This surface engagement was characterised by students' focus on short-term goals, such as completing assignments and preparing for exams. However, as the TEFAs were refined to be more interactive and to provide immediate feedback, a gradual shift towards deeper, more consistent engagement was observed. This deeper engagement was characterised by students' active participation in the learning process, where they engaged with the material not just for exam preparation but for a genuine understanding of the content. The incorporation of elements such as interactive question types and real-time feedback and next day long question feedback helped in maintaining the students' interest and motivation throughout the term. These findings suggest that well-designed, technology-enhanced assessments can foster sustained engagement by promoting active participation. The study has shown that when students are provided with opportunities to interact with the content in meaningful ways and receive immediate, constructive feedback, their engagement levels are likely to increase, leading to a more enriching learning experience.

7.2.2. Impact on Learning Outcomes

Research Question: What are the effects of technology-enhanced formative assessments on the learning outcomes of a selected population of students?

The primary aim of this question was to explore how TEFAs influence measurable academic performance, for instance, exam scores, understanding of content, or other demonstrable learning outcomes. Quantitative data from this study showed mixed results. While some students displayed incremental gains in their final exam scores or coursework performance after the use of TEFAs, others did not exhibit statistically significant improvements. These inconsistent outcomes suggest that multiple factors, such as individual motivation, prior academic preparation, and course workload, can mediate how effectively students translate formative gains into success in their summative assessments.

Nonetheless, qualitative and survey feedback indicated that many students felt more confident in engaging with course content, citing timely feedback as key to identifying and correcting misunderstandings. In particular, some students credited the iterative nature of the quizzes, where multiple attempts were allowed, with fostering a growth mindset (Rhew et al., 2018). Because they could see mistakes as opportunities to learn rather than as final failures, participants reported adopting more positive attitudes toward coursework and sometimes persisting longer with challenging tasks. As mentioned above, while this shift in mindset did not always translate into uniform exam gains, several students noted small but meaningful improvements on specific exam items closely aligned with quiz content. Moreover, frequent exposure to content through the quizzes seemed to support knowledge retention. Some participants, especially those who completed more attempts, performed better on targeted questions in their final exams. However, the lack of a clear, overarching improvement in summative metrics highlights a possible disconnect between perceived learning growth and objective academic outcomes. For instance, external pressures (time constraints, workload in other classes) could have limited the extent to which students applied or extended what they learned from TEFAs to broader assessments.

7.2.3. Student Perceptions

Research Question: How do the students participating in the study perceive the impact of technology-enhanced formative assessments on their learning processes?

Students generally perceived TEFAs positively. They appreciated the interactive nature of the assessments and the immediate feedback, which helped them to stay motivated and engaged. Survey data and qualitative feedback indicated that students found these assessments useful for understanding course material and felt they contributed to their overall learning process. However, maintaining consistent engagement throughout the semester was a challenge. Some students reported initial enthusiasm for the new assessment format but experienced a decline in motivation over time. This suggests the need for continuous refinement of assessment strategies to keep students engaged. Incorporating varied types of question types helped maintain interest and engagement by offering different modes of interaction and evaluation. Additionally, some students faced technical difficulties or had limited access to necessary digital resources, highlighting the importance of ensuring technological accessibility and providing adequate support to all students. Addressing these challenges was found to be crucial

for maximising the benefits of technology-enhanced assessments and ensuring that all students could fully participate and benefit from these innovations.

7.2.4. Challenges for Educators

Research Question: What challenges do educators face when implementing technology-enhanced formative assessments, and how can these challenges be mitigated?

Several challenges were encountered when implementing the quizzes. These included the significant time and effort required to design, implement, and maintain these assessments, as well as technological issues and varying levels of student engagement. The literature shows that designing effective TEFAs requires educators to have a deep understanding of both the technological tools and the pedagogical principles underpinning formative assessment (Kiersey et al., 2018). For me, this often involved a steep learning curve, and no doubt would be the case for other educators, especially for those less familiar with digital tools. Additionally, the ongoing maintenance of these assessments, such as updating content, troubleshooting technical issues, and providing continuous feedback, significantly added to the workload. While these tasks remained onerous and required my ongoing time and effort, they did become more manageable over time. As I developed structured processes for making iterative improvements and also became more familiar with the digital tools, my confidence grew, and I was able to streamline certain aspects of the work. However, the time investment should not be underestimated.

The findings of this study suggest that, to mitigate these challenges, there is a need for comprehensive professional development for educators. These programmes could address not only the technical aspects of using digital tools but also focus on pedagogical strategies grounded in the study's customised LOA-TPACK framework, which aligns technology with formative assessment goals to promote engagement and learning. This framework is offered to educators as a guide to integrating digital tools in ways that support content mastery, self-regulated learning, and continuous feedback. Workshops, webinars, and collaborative professional development sessions might be considered in future with a view to helping educators build the necessary skills and confidence to effectively use these tools. These ideas are expanded upon in Section 7.4. Recommendations for Educational Practice, and Section 7.5 Recommendations for Future Research, later in this chapter. As evidenced in the Literature Review in Chapter 2, institutional support and resources present an ongoing challenge in implementing and

sustaining technology-enhanced assessments. It has also been shown that without adequate infrastructure and professional development, integrating technology effectively into teaching practices can be difficult. This challenge, identified in the study, is also discussed further in Section 7.6 Recommendations for Policy, where suggestions for policy enhancements are provided to support educators in this area.

7.3. Significance of the Study

This study provides a significant contribution to research in the areas of educational technology and assessment, particularly through the development of a customised framework for integrating TEFAs. The framework developed in this study emphasises the alignment of digital tools with pedagogical goals, ensuring that the use of technology directly supports student engagement, self-regulated learning, and academic achievement. This aligns with the principles of Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK), highlighting the importance of carefully integrating technology into educational practices to enhance learning outcomes. This study's explicit synthesis of LOA and TPACK addresses key theoretical gaps in existing frameworks. LOA effectively emphasises formative feedback and student-centred assessment but lacks sufficient guidance on the technological and foundational pedagogical competencies required for effective implementation. TPACK provides robust support for integrating technology, pedagogy, and content, yet it does not offer explicit guidance on formative feedback processes and student-centred learning. The innovative integration of these frameworks provides a new, practical model for educators, uniquely designed to leverage the strengths of both frameworks and overcome their individual limitations.

It is hoped that one of the primary contributions of this study will be its potential to inform and improve pedagogical practices. By exploring how TEFAs can provide immediate feedback and foster student engagement, the research addresses notable gaps in the literature. This study highlights the practical application of digital tools in real-time feedback and interactive learning paths, offering educators actionable insights to enhance their teaching strategies. The findings of this research offer valuable empirical evidence in an under-explored area, specifically, the implementation and impact of formative assessments in digital learning environments within the context of higher education in Ireland. Previous research has primarily focused on the theoretical benefits of formative assessments, but there has been limited exploration of their practical

integration with educational technologies. This study addresses this gap, providing a framework that can guide educators in leveraging digital assessments to foster student learning and engagement.

This research further suggests that institutions could benefit from investing in technological infrastructure and providing continuous professional development for educators, as these were found to be key factors in the effective implementation of TEFAs within this study. It is recommended that institutions establish a supportive environment that includes accessible resources and targeted professional development, as these can enable educators to use TEFAs more effectively and potentially enhance student engagement and learning outcomes. Based on these findings, institutions might consider developing comprehensive strategies to integrate digital tools across their curricula in ways that are both sustainable and supportive of pedagogical goals. The transformative potential of TEFAs is evident through the continuous feedback mechanisms they provide, which can help students develop a deeper understanding of course material and improve academic performance. The study's findings demonstrate the practical benefits of integrating TEFAs into teaching practices, making it valuable not only in a theoretical sense but also for its real-world applications in educational settings.

Finally, this research lays the groundwork for future inquiry in the field of educational technology. It identifies critical areas for further exploration, such as the long-term effects of TEFAs and the roles performed by artificial intelligence and adaptive learning technologies in enhancing assessment practices. These areas represent significant opportunities for further research, which can expand on the findings of this study and build a deeper understanding of how technology can be used to support teaching and learning in higher education.

7.4. Recommendations for Educational Practice

This section draws on the conclusions from the research to identify the practical implications of technology-enhanced assessments. It explores how to address cultural hurdles within traditional educational settings, teacher attitudes towards technology, and diverse learning preferences. Additionally, it highlights the role of assessment literacy, the necessity of personalised learning paths, and the strategic adoption of technology in education. By examining these factors, conclusions can be drawn about

how to support educators and students in leveraging technology to enhance learning outcomes.

7.4.1. Cultural Hurdles in a Traditional Educational Sector

Reflecting on my role as an educator, I realised that while my intention was to teach students how to learn, there was an implicit emphasis on using quizzes to prepare for final exams, aligning with the values of summative assessments. This issue, rooted in Ireland's second-level education system, which prioritises high-stakes exams, influences the higher education context as well. To address these cultural hurdles, a redefining of the role played by formative assessments is required. This should also be done in a manner that enhances assessment literacy and acknowledges the influence of prior educational experiences. As noted in the Introduction (Chapter 1), traditional assessment practices in Ireland often focus on memorisation and exam preparation, limiting the development of critical thinking. Shifting towards a culture that values formative assessments can encourage continuous learning and feedback, as discussed in the Theoretical Framework (Chapter 3). Educators and students must better understand the benefits of formative assessments, which provide ongoing feedback and help guide learning. The action research Findings (Chapter 5) highlight that improving assessment literacy can enhance student engagement and learning outcomes. Additionally, recognising students' previous exam-focused experiences is crucial for supporting their transition to a more formative, learning-oriented approach, as noted in the Discussion chapter (Chapter 6). The Findings (Chapter 5) show that students who received continuous feedback were more engaged and performed better academically, demonstrating the value of regular, low-stakes formative assessments.

7.4.2. Learning Preferences and Study Habits

The diverse learning preferences among students participating in this study indicate that a one-size-fits-all approach to formative assessment is unlikely to be effective, leading to a recommendation that educators recognise and accommodate these differences by providing a range of learning options. Offering both digital and conventional learning resources allows students to choose methods that align with their preferences and strengths. For instance, pairing online quizzes with traditional review sessions can cater to both tech-savvy students and those who prefer face-to-face interactions, as pointed out in the Discussion (Chapter 6). Introducing digital tools gradually and providing adequate support can help students transition more comfortably. Tutorials, practice

sessions, and continuous support could alleviate anxiety and build confidence in using these tools. A recommendation backed up by the literature reviewed in Chapter 2, including authors such as Laurillard (2008a) and Blondeel et al. (2023), emphasises the importance of gradual integration to ensure that students do not feel overwhelmed by new technologies. Interestingly, this gradual approach is important for educators too (Harrison, 2013; Murchan & Shiel, 2024). It is recommended that educators consider creating personalised learning paths that incorporate both traditional and digital methods to more effectively address individual student needs. By acknowledging the unique study habits of each learner, educators can tailor the learning experience to better support engagement and understanding. Gathering regular feedback from students on their experiences with both traditional and digital approaches can inform and refine instructional strategies over time. This iterative, feedback-informed process ensures that educational approaches remain responsive to changing student needs, as highlighted in the Discussion, Chapter 6.

7.4.3. The Role of Education and Assessment Literacy

To address cultural challenges in assessment practices, this study recommends targeted education initiatives to enhance assessment literacy, focusing on the role and benefits of formative assessment. The findings showed that, for students, formative assessments need to be framed not merely as preparation for summative exams, but as essential components of their learning journey. Educators, therefore, need to promote a shift in students' mindsets, encouraging them to see formative assessments as opportunities to engage more deeply and holistically with course material. In line with the customised LOA-TPACK framework developed and tested in this study, it is recommended that educators use consistent, constructive feedback and transparent communication about the purposes of formative assessments. This approach can reinforce the view of assessments as growth opportunities, fostering sustained student engagement and improved learning outcomes. Iteratively refining assessment tools, such as quizzes, based on feedback and performance data can further support continuous student engagement and deeper learning.

7.4.4. Monitoring and Adjusting to Student Needs

Based on the feedback collected during this study, it is beneficial for educators to adjust various aspects of quizzes to cater to diverse student needs. This could include modifying the difficulty level to ensure it offers appropriate challenges without

overwhelming learners. For instance, if students find the quizzes consistently too difficult, gradually reducing complexity or providing additional support materials might alleviate stress while promoting growth. Conversely, if quizzes are too easy for some students, increasing the difficulty levels could help sustain engagement and foster deeper learning. In the constantly changing educational landscape, as demonstrated by the action research cycles, adopting a responsive approach that involves ongoing assessment adjustments is essential for meeting the diverse needs of students. When implementing TEFAs, such as quizzes, the findings of this study show that it is beneficial to adopt a dynamic and adaptable strategy to ensure they remain both effective and relevant. The monitoring of the impact of quizzes on student learning could involve gathering and analysing data from multiple sources, including performance metrics, feedback surveys, and direct observations. Based on this study, this comprehensive approach would enable educators to gain a deeper understanding of how students engage with the assessments and to pinpoint any areas for refinement. For example, tracking quiz completion rates, scores, and time taken can reveal insights into the quizzes' difficulty and engagement levels. High completion rates and high scores may indicate that quizzes are too easy, while low completion rates and scores could suggest they are too challenging. Additionally, monitoring patterns in student feedback may highlight preferences and recurring concerns, such as quiz length or question clarity.

Another important consideration is the frequency and format of quizzes. Regular, spaced assessments are shown to reinforce learning and improve retention, although the optimal frequency can vary depending on course content and student workload. Some students may benefit from weekly quizzes, while others might find bi-weekly or monthly assessments more manageable. Additionally, experimenting with different quiz formats could increase engagement and effectiveness. While multiple-choice questions are useful for assessing recall and basic understanding, incorporating varied question types, such as short-answer questions, open-ended essay questions, and application-based questions, can offer a more comprehensive assessment of student learning. The comments from students who participated in the study revealed that diversifying formats also accommodates different learning styles and keeps the quizzes engaging.

As educational technology continues to evolve, so too should the tools used in assessments. Staying updated with the latest tools can provide new opportunities to enrich the learning experience. For example, integrating interactive elements such as simulations, drag-and-drop activities, or video-based questions can make quizzes more engaging. It is also important to consider accessibility, such as selecting platforms that work across various devices and internet speeds. In some instances, it may be necessary to provide alternatives for students facing technological barriers. By remaining adaptable and open to new tools, educators have the opportunity to enhance the effectiveness and inclusivity of assessments. Ultimately, monitoring and adjusting assessments helps ensure their ongoing relevance and their ability to support student learning effectively. This requires a commitment to ongoing evaluation and a willingness to make iterative changes based on student needs and feedback. For example, if a particular quiz topic proves problematic on a consistent basis, it may be necessary to revisit instructional approaches or to supplement current offerings with additional resources that could address those issues effectively.

7.4.5. Improving Feedback Quality and Efficiency

The study showed that technology-enhanced assessments facilitate timely and detailed feedback, which is crucial for the learning process. Tools that allow for automated feedback on quizzes or assignments showed that they can provide immediate responses to students, helping them understand their errors and learn from these errors without delay. This has implications for teaching efficiency, as it can reduce the workload on educators, which in would in turn allow them to focus more on personalised instruction and less on routine grading. Educators are likely to benefit from selecting and designing automated feedback systems that provide not only prompt responses but also meaningful and constructive feedback that supports student learning and engagement.

7.4.6. Professional Development for Educators

My experience over the action research cycles suggests that the effective integration of technology into assessment processes requires educators to engage in substantial professional development. Based on the findings, it is recommended that institutions offer ongoing professional development programmes that equip educators with the necessary skills in pedagogy and technology. This would include how to effectively implement and leverage technology to improve student engagement, how to enhance learning outcomes, and how to foster a more interactive learning environment. Such

professional development should encompass both the technical aspects of new tools and pedagogical strategies to ensure that technology enriches teaching and assessment practices in meaningful ways.

7.4.7. Innovation v Pedagogy

The integration of innovative technologies in education raises important questions about balancing technological advancements with established pedagogical practices. This research highlights the importance of aligning technology with pedagogy to enhance learning outcomes effectively. While technology offers significant advantages, such as increased engagement and efficient feedback, it is recommended that technology remain a supportive tool for educational goals rather than an objective in itself. Effective technology integration, therefore, involves a thoughtful selection of tools that uphold pedagogical aims. For example, while gamification in quizzes can boost engagement, such elements should be designed to reinforce learning objectives rather than simply entertain.

Educators play a central role in shaping technology-enhanced assessments to ensure these tools align with sound pedagogical principles. Involving educators in the design and implementation processes of technology-based assessments is essential to make sure that these tools are pedagogically effective and meet the specific needs of students. Continuous professional development and institutional support are recommended to enable educators to use these technologies in ways that enhance teaching and learning, while safeguarding the integrity of foundational teaching practices. The research also highlights technology's potential to foster student-centred learning by providing immediate feedback and self-assessment opportunities that support independent learning and self-regulation. However, it remains essential to strike a balance where technology complements, rather than replaces, traditional teaching approaches, fostering a cohesive and supportive educational environment.

7.4.8. Effective Quiz Design Strategies

The design of quizzes plays a critical role in the effectiveness of formative assessments. Well-designed quizzes not only assess student knowledge but also promote deeper learning and engagement. This research provides several insights into the key elements of effective quiz design in the context of TEFAs. It is recommended that quizzes be aligned with clear learning objectives to ensure they assess relevant knowledge and skills. Each question should also be designed to measure specific student learning

outcomes, helping them focus on essential concepts and practices. As noted earlier, incorporating a variety of question types, such as multiple-choice, short answer, longer essay-type and application-based questions, caters to different learning approaches and cognitive levels. As shown in this study, this variety not only makes quizzes more engaging but also provides a comprehensive assessment of student understanding.

The findings have shown that immediate and detailed feedback is central to effective formative assessment. The research highlights the benefits of quizzes designed with automated feedback systems, which can help students identify and correct mistakes promptly, reinforcing learning and boosting confidence. While automated feedback is a powerful tool, it does have limitations, as it may not provide the depth or individualised guidance that some students may need, a consideration that was raised in the Discussion chapter. Based on what the students reported, constructive feedback is recommended, guiding students toward improvement and helping them deepen their understanding.

In this research, the iterative nature of quiz design involved continuous refinement based on student feedback and performance data. This iterative process ensures that quizzes remain effective and aligned with changing educational needs and standards. Although adaptive learning technologies were not leveraged in this study, they could offer further personalisation by adjusting question difficulty based on student performance, which could better support individual learning needs. By balancing innovation with pedagogical principles in this way, educators can create effective and engaging assessment tools that can enhance the educational experience. The synthesised LOA-TPACK framework developed in this research provides educators with explicit guidance on achieving this balance, emphasising that effective formative assessments require an integration of technological, pedagogical, and content considerations. The study’s findings reinforce the framework's utility in practical applications, highlighting its value as a tool for educators seeking to optimise their formative assessment strategies within technology-enhanced environments.

7.5. Recommendations for Future Research

This study has offered valuable insights into the implementation of TEFAs and their impact on student engagement and learning outcomes, while also identifying areas that could benefit from further investigation. The theoretical framework developed in this study may also serve as a useful foundation for future research, offering a structured

lens through which to explore the interplay between pedagogy, technology, and assessment. Extending the findings of this research could help deepen understanding of TEFAs' broader applications. This includes their adaptability across diverse educational contexts, and the considerations needed for learner diversity, educator support, and emerging technological tools. The following sections present specific avenues for future research, organised around key themes related to learners, educators, and TEFA design.

7.5.1. Research Focused on Learners

This study provided valuable insights into how TEFAs influence student engagement and learning outcomes, particularly within the specific educational context examined. However, further research could explore how TEFAs can be adapted to meet the diverse needs of learners across different academic levels, learning preferences, cognitive abilities, and socio-economic backgrounds. While this research demonstrated improvements in student engagement through TEFAs, it also identified barriers, such as varying levels of digital literacy and access to resources. These barriers could limit the effectiveness of TEFA usage for some students. Additionally, this study did not fully explore the potential of adaptive learning technologies, i.e., tools that can adjust content and difficulty levels in real time, to further personalise assessments based on individual learner performance. Additionally, while this study highlighted the digital divide as a factor affecting student access to technology-enhanced assessments, further research might examine how adaptive technologies can be used to bridge this gap. Investigating how TEFAs can be made more inclusive and accessible, especially for students from disadvantaged backgrounds, or those with specific learning disabilities, would build upon the findings of this study. Incorporating universal design for learning (UDL) principles, which were not a central focus in this research, could be a key area for future exploration to ensure that assessments are accessible to all learners. This study also noted variability in student motivation and engagement, but it did not fully investigate how different forms of feedback, such as instantaneous, delayed, or personalised, might influence these dynamics. Further research could extend this by examining the role of feedback in enhancing motivation across different learner profiles, particularly for students who may not respond well to traditional assessment formats. Understanding how different feedback mechanisms impact engagement might help to further refine the design of TEFAs to better meet the needs of all learners.

Moreover, while this research tracked the first cohort of participants over an entire academic year (ARC1 and ARC2) and the second cohort over a single semester (ARC3), longer-term studies would be necessary to explore the sustained impact of TEFAs. Longitudinal research could track a cohort of students over multiple academic years to determine whether the benefits observed in this study, such as increased engagement and improved learning outcomes, are maintained over time. Such studies could build on the initial findings of this research to assess whether TEFAs contribute to lasting academic progression and the development of critical thinking skills throughout the academic life of participants.

Finally, this study did not extensively examine how external circumstances, such as personal commitments (work, family, financial responsibilities), affect students' use of TEFAs. Future research could address this gap by investigating how these external factors influence engagement and learning outcomes. By designing TEFAs that are flexible and responsive to students' real-world challenges, future studies might lead to the development of more equitable assessment systems that support all learners, particularly those facing complex life demands.

7.5.2. Research Focused on Educators

This study has demonstrated the significant role that educators play in the effective implementation of TEFAs. However, while the findings highlighted some of the challenges educators face, such as the time and effort required to design and implement these assessments, further research is needed to delve deeper into the specific pedagogical strategies that can support educators in this process. Future studies could examine how educators can be better equipped to integrate TEFAs into their teaching practices, particularly in relation to aligning these tools with broader curricular goals.

One of the limitations of this study was that it was beyond the scope of the research to fully explore the impact of professional development on educators' ability to effectively use TEFAs. While there were some professional development opportunities available for me, they certainly were not plentiful, and I did not always have the time to participate in them. These challenges indicate that other educators in higher education may still lack CPD opportunities and also the sufficient time and resources to adopt and sustain their technological interventions effectively. Future research could address this gap by investigating the types of professional development and support that would most effectively enable educators to design, implement, and refine TEFAs. For instance,

studies could explore how professional development programmes that focus, not only on the technical aspects of TEFAs but also on their pedagogical integration could lead to more effective use of these tools.

Moreover, this research found that the effort required by an educator to create and maintain TEFAs can be substantial, particularly in terms of time spent designing quizzes and assessments. However, the study did not include a comprehensive exploration of how this effort compares to the potential efficiencies gained over time. Future research could conduct a more detailed cost-benefit analysis, evaluating the initial workload involved in creating TEFAs against the longer-term efficiencies they might provide, such as reduced grading time or more streamlined feedback processes. Such studies would help institutions better understand the resource demands on educators and the potential return on investment in terms of both educator workload and student outcomes.

Another area that warrants further exploration is the development of collaborative models for TEFA implementation. This study noted that the integration of technology into assessments can often be a solitary task for individual educators, but further research could investigate how collaborative approaches, such as team-based development or peer support networks, could enhance the implementation process. Collaborative models might also help distribute the workload more equitably and foster innovation in assessment design, as educators share insights and strategies for leveraging TEFAs effectively.

Finally, this research primarily focused on the educator's role in implementing TEFAs within their immediate teaching context. Future studies could expand on this by exploring how institutional policies and leadership support opportunities influence educators' ability to adopt and sustain these technologies. Understanding the institutional factors that either facilitate or hinder the integration of TEFAs could provide valuable insights for developing more supportive environments for educators. For instance, further research could examine how leadership initiatives, such as institutional funding for technology or time allowances for educators to engage in professional development, would impact the success of TEFA implementation.

7.5.3. Research Focused on Technology-Enhanced Formative Assessments

This study highlighted the significant role that TEFAs can play in improving student engagement and learning outcomes. However, it also uncovered several areas where

further research would shed new and important light on how to optimise the use of these technologies. While the study explored some of the practical challenges associated with TEFA implementation, such as time constraints and technological dependencies, additional research could examine how to enhance the scalability and adaptability of these tools across various educational settings. Specifically, future studies could focus on understanding the most effective ways to integrate TEFAs into diverse curricula, ensuring that they align with specific learning goals while remaining flexible enough to accommodate different teaching styles. In the previous section, we saw how these developments support student learning and development. However, these findings further suggest how these developments support the professionalisation of educational practice, which is an issue that calls for future research.

Artificial Intelligence (AI) and Personalisation in TEFAs

As artificial intelligence (AI) continues to evolve, there is growing interest in how AI could further enhance and personalise TEFAs. Future research might focus on developing and rigorously evaluating AI-driven tools that streamline quiz creation, provide advanced feedback, and adapt content to individual learner needs. This section outlines several potential directions and considerations for researchers, educators, and policymakers.

Recent innovations illustrate how AI can support quiz design and administration. Tools such as Author Aide (2023) and Feedback Aide (2024) developed by Learnosity, demonstrate how automated systems might generate or refine assessment items and offer immediate feedback (Learnosity, 2023). Such advances promise efficiency gains for educators, who often face significant time constraints in designing and delivering high-quality assessments. However, investigating the pedagogical impact of these tools, along with their user experience and ethical considerations, remains an important area for future inquiry. AI also promises to facilitate more personalised learning by tailoring quizzes and assignments to each student's capabilities and progress. Zawacki-Richter et al., (2019) discuss how Intelligent Tutoring Systems (ITS) adapt content difficulty based on individual performance. Yet, future studies could examine how well these adaptive features balance standardisation with the creative and critical thinking skills that are core to deep learning. Researchers could, for instance, explore ways to maintain flexibility in AI-driven systems while allowing for diverse learning pathways.

Another key area for research is scalability. AI-driven feedback and grading can potentially handle large enrolments more efficiently (Hooda et al., 2022), but the broader implications merit further investigation. For example, Zawacki-Richter et al. (2019) raise questions around data privacy, as AI systems often rely on extensive student data collection. Future studies could assess how to implement robust privacy safeguards while still benefiting from scalable analytics. Bearman et al. (2023) similarly highlight the importance of data security, suggesting that effective protocols must be established to build trust in AI-assisted educational environments, and that is another area that needs investigation.

Despite its potential, AI on its own is not necessarily the ultimate solution to educational problems (Rahiman and Kodikal, 2024). Farrelly and Baker (2023) also caution that efficiency gains must be balanced with human oversight to ensure alignment with genuine learning objectives and ethical standards. Further research might address how AI tools interact with equity concerns, such as differential access to technology, and explore guidelines for designing AI systems that uphold inclusivity and student wellbeing.

Economic Viability of TEFAs

One of the gaps identified in this study relates to the economic considerations of TEFA adoption, particularly in terms of cost-effectiveness and resource allocation. While this current study highlighted the significant investment of time and effort required from educators to design and maintain TEFAs, it did not fully explore the financial costs associated with integrating such technologies at an institutional level. Future research could focus on conducting a detailed cost-benefit analysis, examining the economic viability of TEFAs across different educational institutions, from well-resourced universities to more resource-constrained environments. Such research could evaluate the direct costs of technology procurement, maintenance, and software licensing, as well as the indirect costs related to educator professional development for educators and technical support. By comparing these costs to the educational benefits realised through increased student engagement and improved learning outcomes, future studies could provide a clearer picture of the economic sustainability of TEFAs. This would be particularly important for institutions that are considering investing in AI-driven assessment technologies, as the return on investment (ROI) would need to be carefully

weighed against potential savings in administrative time and improvements in student performance.

Sustainability and Institutional Support

Another area this study touched upon was the need for ongoing institutional support to ensure the long-term sustainability of TEFA implementation. Although the research highlighted the benefits of these assessments, it also suggested that without proper support structures, such as continuous professional development, technical support, and infrastructure investment, educators may struggle to maintain their use effectively. Future research could investigate how institutions might develop more sustainable models for supporting the ongoing use of TEFAs. This could include studying how professional development programmes can be designed to keep pace with technological advancements, as well as exploring how institutions can better allocate resources to ensure that both educators and students have access to the necessary tools for effective TEFA usage.

Cross-disciplinary and Cross-cultural Studies

This study provided valuable insights into how TEFAs (TEFAs) can be effectively implemented within a specific educational context. However, the research was limited to a single institution and focused primarily on one student demographic. Future research could expand upon these findings by exploring how TEFAs perform across different academic disciplines and cultural settings. By examining the unique challenges and opportunities presented by different subject areas, such as STEM versus humanities, or by diverse cultural contexts, researchers could gain a more comprehensive understanding of the adaptability and effectiveness of TEFAs. While this study highlighted the benefits of TEFAs in improving student engagement and learning outcomes, further cross-disciplinary and cross-cultural studies could help determine whether these benefits are transferable to other educational settings. Such research could also investigate how cultural differences impact students' responses to digital feedback, engagement with technology, and learning outcomes, providing critical insights into how TEFAs can be adapted for more inclusive use in a global context.

Strengths of the Research Design

This study's research design incorporates several strengths that contributed to both the depth and validity of the findings. By employing a mixed-methods approach, integrating

longitudinal and iterative cycles, and incorporating reflective practice, the research was able to provide nuanced insights into the impact of TEFAs in higher education. These strengths not only bolster the credibility of the research but also contribute to the field of educational technology by demonstrating how such assessments can be effectively integrated into teaching practices. While there are limitations inherent in any research, as outlined in the following sections, the design of this study ensures that the findings are well-grounded and applicable to similar educational contexts. The following subsections outline the key strengths of the research design and their contributions to advancing knowledge in this area.

Comprehensive and Longitudinal Data Collection

A primary strength of this research lies in its mixed-methods approach, which allowed for comprehensive data collection across both quantitative and qualitative dimensions. Quantitative metrics such as attendance rates, exam scores, and LMS analytics were combined with qualitative insights from interviews, focus groups, and student surveys, creating a comprehensive dataset that captured multiple perspectives on student engagement and learning. The longitudinal nature of the study, spanning an entire academic term, further strengthened this approach by enabling the exploration of how the effects of TEFAs evolved over time. This longitudinal perspective provided valuable insights into the sustainability and long-term impact of these interventions, contributing to a deeper understanding of their effectiveness.

Iterative Design and Reflexivity

The research design followed an iterative process where initial findings were used to refine both the methods and the TEFAs in subsequent cycles. This adaptive approach, characteristic of action research, allowed for real-time improvements based on feedback and ongoing data analysis. Reflexivity also played a key role, as I, in my role as researcher, actively reflected on my influence and continually adapting practice throughout the study. This reflexive component contributed to the credibility and ethical integrity of the research.

Technological Integration and Innovation

The integration of cutting-edge educational technologies, particularly the Learnosity platform, into the assessment processes was another strength. This study was not only an exploration of the impact of TEFAs, but also a demonstration of how advanced technology can be used to enhance both engagement and assessment quality. By testing

these technologies in a real-world educational setting, the research contributed to the field of educational technology by illustrating practical applications that other educators might adopt or adapt for their own practice.

Balancing Standardisation with Flexibility

A challenge that became a strength was the balance between maintaining standardisation in research design and allowing flexibility to adapt to real-world educational settings. While standardisation was necessary for ensuring the validity of findings across different groups, the flexibility in how assessments were implemented allowed for responsiveness to unique classroom dynamics to develop simultaneously. Although this introduced some variability, it ultimately enhanced the research by capturing a more authentic picture of how TEFAs work in practice.

Evaluation and Reflection

A key strength of this research lies in the regular evaluation and reflective practices embedded throughout the study. Educators, including myself as the action researcher, continuously assessed the effectiveness of the TEFAs through a combination of student feedback, performance data, and peer reviews. This iterative evaluation process enabled real-time adjustments and improvements, ensuring that the assessment strategies remained aligned with students' changing needs and institutional goals. By incorporating these reflective practices, the study not only enhanced the reliability of the findings but also modelled a responsive and adaptable approach to educational practice, underscoring the importance of continuous professional learning and development.

Limitations of the Research Design

Sample and Contextual Limitations

While convenience sampling was employed to recruit participants for focus groups, this method may have led to the creation of a sample that is not fully representative of all student experiences. However, the insights gained still offer valuable reflections on the student engagement with TEFAs in this specific context. While the findings of this study offer valuable insights into the specific context in which the research was conducted, the overall engagement remained below what would be expected in a broader-scale project. Although the classes involved were relatively large, the intention was always to concentrate on my own students rather than incorporating other classes that I did not teach. This decision allowed for in-depth action research within a familiar

environment but combined with lower-than-hoped-for levels of participation, both in the TEFAs themselves and in follow-up feedback, the scope and the range of data obtained was limited. Because action research is inherently context-bound, the findings remain specific rather than universally generalisable. Nevertheless, the detailed reflections generated here retain value for practitioners in comparable contexts, where these insights can be adapted to the particular demands of local educational settings.

Resource and Technology Constraints

Time constraints, particularly due to the demands of semesterised modules, posed challenges during the research process. These limitations affected the amount of data that could be gathered and analysed, as well as the time available to make iterative improvements to the TEFAs. In addition, while access to the Learnosity platform provided significant benefits in developing and deploying the TEFAs, this level of access may not be attainable for all researchers. This could, potentially, limit the replicability of certain aspects of this study. However, working with an external platform also introduced challenges. Technical issues, such as software glitches and occasional downtime, disrupted the assessment process and affected the consistency and reliability of the data collection. Despite these challenges and constraints, the research remained focused and comprehensive in scope.

Potential Bias and Subjectivity in Interpretation of Findings

While the subjective nature of some qualitative methods, such as surveys and focus group discussions, can introduce personal biases into data interpretation, measures were taken to mitigate this risk. As discussed in detail in Section 4.5. Ethical Considerations, every effort was made to overcome biased interpretation included documenting student responses verbatim and practising reflexivity throughout the research process to minimise potential bias.

Engagement and Response Rates

A persistent challenge was maintaining high engagement and response rates from participants. Despite initial enthusiasm, some students' participation waned over time, particularly in completing follow-up surveys and engaging in focus group discussions. Reminders and personal follow-ups were increased to maintain student-focus and engagement. However, the variability in response rates remained a limitation that was evident in the data.

7.6. Recommendations for Policy

Given the transformative potential of technology-enhanced assessments documented through the findings of this study, it is recommended that policymakers within higher education institutions and government departments consider the insights from this study when making strategic decisions about educational technology integration. The following recommendations, based on the findings of this research, aim to ensure that the integration of technology in formative assessments is effective, equitable, and sustainable.

7.6.1. Main Recommendations

Investing in Technological Infrastructure

It is recommended that policymakers ensure educational institutions are equipped with the necessary technological tools and high-speed internet access to support the deployment of digital assessments. The findings from this research highlight the critical role of reliable technology in enabling effective formative assessments, as students' engagement and ability to benefit from technology-enhanced learning (TEL) environments were directly impacted by access to tools and infrastructure.

Developing Clear Standards and Guidelines

The study has shown that establishing comprehensive standards for TEFAs is essential. Based on the findings, which highlighted variability in the effectiveness of assessments across different implementations, clear guidelines are necessary to ensure consistency, accessibility, and pedagogical soundness across diverse educational contexts. It is recommended that these standards be developed collaboratively, involving policymakers, educational leaders, and educators themselves to ensure that guidelines reflect both institutional goals and the practical, day-to-day needs of educators. By involving educators in this process, institutions can safeguard teaching autonomy, allowing for flexibility in how technology is used within the agreed-upon framework. This approach can also ensure that there is maximum accessibility, which is to say that all students, regardless of socio-economic background or learning needs, can benefit from advanced educational technologies.

Supporting Research and Development

Encouraging innovation in educational technology through funding and policy support can help advance the development and refinement of assessment tools. The findings show that technology-enhanced assessments are continually advancing, and so it is

suggested that continued research into their pedagogical effectiveness will help to align tools with the dynamic needs of students and educators.

Ensuring Equity in Higher Education

In order to address digital equity issues, the findings suggest that specific educational policies and institutional guidelines in higher education are required. In particular, policies should define clear standards and support mechanisms ensuring that every student has reliable access to appropriate devices and internet connectivity. This is particularly true when it comes to formative assessments. Unlike summative assessments, which may be spaced out, or limited to final exams, formative assessments are typically frequent, ongoing, and designed to provide continuous feedback and support. This sustained use of technology throughout the term means that digital equity becomes especially important, as unequal access to devices or internet connectivity could prevent students from fully participating in these formative opportunities. Addressing this could involve implementing support structures, such as laptop rental schemes, discounted or subsidised technology, and access to high-speed internet, to ensure that no student is disadvantaged by a lack of resources. Additionally, continuous institutional support for students throughout the semester is critical to maintain equitable access to formative assessments and the benefits they offer for learning progression.

Policy and Resource Allocation

For educational institutions, it is recommended that policy frameworks support the integration of technology into assessment practices. This recommendation stems from findings that highlighted the need for both financial and technical support to enable educators to adopt innovative assessment tools effectively. This includes providing necessary resources such as funding for technology tools and professional development programmes for lecturers, for example, and developing policies that encourage innovative assessment practices. Policymakers are encouraged to consider infrastructural requirements and potential disparities in technology access among students to ensure equitable opportunities for all learners.

Incentivising Innovative Practices

It would be helpful if educational policies incentivise schools and educators to adopt innovative assessment practices. The findings demonstrated that when educators were provided with opportunities to experiment with new tools and methods, student

engagement and learning outcomes improved. Incentivising such practices would further promote widespread adoption. This could be through recognition programs, additional funding, or resources that reward institutions demonstrating effective use of technology in formative assessments.

Privacy and Data Protection

As shown in the rigorous ethical approval process in this research, it is suggested that, as technology-enhanced assessments increasingly involve the collection and analysis of large amounts of student data, policies are needed to enforce strict standards for data privacy and security. The findings raised concerns regarding the ethical implications of using digital tools in assessments, particularly regarding data collection and storage. Therefore, policies that safeguard students' privacy are crucial. This would include regulations that protect student information from misuse and ensure transparency in how data is collected, used, and stored.

Educator Development and Institutional Support

It is recommended that there be a policy-driven mandate for comprehensive professional development programmes that equip educators with the skills needed to effectively implement technology-enhanced assessments. The research findings highlighted the importance of professional development in ensuring the successful integration of technology into formative assessments. Without adequate preparation, educators may struggle to effectively implement these tools. Policies could include regular updates to professional learning opportunities, support for earning professional development credits, and incentives for active participation. It is expected that ensuring educators are well-prepared to use these tools will enhance the effectiveness of technology integration in education. The findings indicate that institutions should play an all-important supportive role if TEFAs are to be integrated successfully. This would involve not only providing the necessary infrastructure and resources but also fostering a culture that values continuous professional development and innovation. Institutional support is crucial in creating an environment where technology can be effectively leveraged to improve educational outcomes. By promoting both comprehensive capacity-building initiatives for educators and strong institutional support systems, the integration of technology in education is likely to be more effective and sustainable.

7.6.2. Challenges and Strategic Considerations

Despite the identified benefits, integrating technology into formative assessments presents several challenges that require careful consideration. Based on the findings of this research, the following recommendations and suggestions are proposed. As effective technology integration depends on the support provided to educators, the findings indicated that professional development opportunities be offered to enhance educators' technological skills. Ongoing technical support and access to resources that facilitate the integration of digital tools into teaching practices would be beneficial. Without adequate support, educators may struggle to use technology effectively, limiting its potential impact.

The findings further suggest that the technology adopted should be closely aligned with curricular goals and learning outcomes. The selection of digital tools and the design of technology-enhanced assessments should be guided by educational objectives. This alignment would ensure that technology serves as a means to achieve pedagogical aims rather than an end in itself.

While technology offers numerous advantages, it also presents potential drawbacks that need to be addressed. These drawbacks include the risk of adopting technology based on presumed benefits rather than demonstrated impact, which is a key concern raised in critical literature on educational technology (Selwyn, 2015; Watters, 2019). This study's findings reinforce the need to remain cautious of techno-deterministic assumptions and to prioritise inclusive, evidence-informed approaches. Issues such as digital distraction, data privacy concerns, and the risk of over-reliance on automated systems can undermine the effectiveness of technology in education. It is advisable, according to the research findings, to develop policies and practices that mitigate these risks to maximise the benefits of technology integration.

7.6.3. Strategic Technology Adoption

This study revealed that adopting technology as part of a broader educational strategy requires a carefully considered, holistic approach that accounts for the interactions between technology, pedagogy, and the learning environment. Throughout the action research cycles, it became apparent that integrating TEFAs effectively into the curriculum depended on meticulous planning and alignment with specific learning objectives. This integration was achieved by selecting digital tools that were tailored to the particular teaching context, designing assessments that fostered student

engagement, and refining these tools based on continuous feedback. The findings highlight that this approach is necessary, not only to support initial implementation, but also to ensure that TEFAs remain responsive to students' changing needs and learning outcomes.

Through the iterative process, I gathered input from students and observed that continuous feedback, coupled with assessment data analysis, was essential for making targeted improvements to the TEFAs. This adaptability, grounded in my customised framework, fostered a stronger alignment between technological initiatives and pedagogical goals. Collaborative input from students, colleagues, and the institution's support staff proved invaluable. These interactions underscored the extent to which shared responsibility and ongoing dialogue are crucial in optimising technology use in education. Therefore, it is recommended that educational institutions support a culture of collaborative refinement and innovation. Encouraging this collaborative approach among educators, students, and technology specialists can help establish best practices, create supportive networks, and collectively advance teaching and learning. By building on the strategic insights drawn from this study, institutions can help ensure that TEFAs are effective, sustainable, and equitable, which will ultimately lead to improved educational experiences and outcomes across diverse learning environments.

Importantly, the strategic integration of TEFAs throughout this study was guided by the customised theoretical framework developed in Chapter 3. By combining the pedagogical strengths of Learning-Oriented Assessment (LOA) with the foundational guidance of TPACK, this framework provided a practical structure for aligning technology, pedagogy, and content. It offered a clear rationale for decision-making throughout the action research process and helped ensure that technology adoption was educationally meaningful, not just operationally efficient.

7.7. Reflections on Professional Growth and Educational Change

7.7.1. Transformative Growth Through Action Research

This research journey has significantly shaped my understanding of the intersections between technology, pedagogy, and assessment. This process has not only enhanced my skills as an educator but also deepened my appreciation for how technology can drive educational change. Influenced by Elliott's (1991) perspective on action research, I have come to view educational change as a dual process that involves both the educator and the students. As I implemented TEFAs, the data gathered prompted me to reflect

upon and subsequently improve my practice, which emphasised the degree to which teaching and research are truly integrated activities.

The importance of continuous professional development (CPD) cannot be overstated. CPD is essential for educators, such as myself, to remain current with new educational technologies and strategies. Through action research, I have actively sought out opportunities to integrate new tools and techniques into my teaching, aligning technological innovation with pedagogical objectives. This approach echoes Elliott's (1991) emphasis on the educator's role in actively shaping educational outcomes through reflective practice. Moreover, my conclusions are that my CPD should extend beyond operational knowledge of new technologies to understanding how to integrate them meaningfully into pedagogy. Institutions can and should play a pivotal role in this process by providing regular access to capacity-building initiatives and structured professional development opportunities. Furthermore, the iterative cycles of action research have proved to be profoundly transformative. I have been inspired to refine my pedagogical strategies while developing a deeper sense of resilience and adaptability. This journey has been marked by continual self-improvement, where the insights gained from the reflective cycles of research have informed both my teaching practice and my approach to technology integration. This journey of self-improvement and professional learning is intrinsically linked to the broader insights I have gained regarding technology's role in education. The next sections, 7.7.2. Technological Upskilling and Integration and 7.7.3. Pedagogical Development will further explore how these insights have been practically applied and the resulting implications for my educational practice.

7.7.2. Technological Upskilling and Integration

Technology played a crucial role in facilitating the formative assessments in this study. The integration of technology provided tools for immediate feedback, enhanced engagement, and streamlined assessment processes. This study has been invaluable in improving my proficiency with various educational technologies, equipping me with the skills to implement technology-based educational solutions and advise others on this process. Successful technology integration requires a strategic approach that considers pedagogical goals, curriculum demands, and the technological competencies of both educators and students. This study highlighted the necessity for a strategic approach that considers these various aspects, ensuring that technology serves to enhance rather than complicate the learning process. I confirmed that support structures, such as

continuous professional development and institutional support, are essential components in order to ensure that the adoption of technology is a positive experience for educators.

7.7.3. Pedagogical Development

This study has significantly deepened my understanding of foundational educational theories, particularly Learning-Oriented Assessment (LOA) and Technological Pedagogical Content Knowledge (TPACK). Engaging with these frameworks has enriched my conceptual grasp and prepared me to design educational interventions and assessments that are both theoretically sound and practically effective. One major insight from this research is the transformative potential of technology to enhance feedback mechanisms within formative assessments. The findings reinforced my belief that technologies that provide immediate, actionable, and personalised feedback can make the assessment process more dynamic and integral to the learning journey. This suggests that there are benefits to be gleaned from to a shift towards tools that facilitate more interactive and responsive feedback, which has profound implications for the development of future educational technologies. Tailoring technology use to specific educational contexts and learning profiles is crucial for maximising its effectiveness. As Yorke (2003, p. 482) asserts, "The act of assessing…has an effect on assessors as well as on students," and this has been evident in my practice as I tailored my teaching based on continuous feedback.

The integration of LOA and TPACK within my customised theoretical framework has not only shaped the study's design but also fundamentally informed my development as an educator. It provided a conceptual structure for aligning pedagogy, assessment, and technology, and offered a clear rationale for my instructional decisions throughout the research process. Engaging with this framework helped me move beyond surface-level technology adoption and towards a more intentional, evidence-based approach to educational design.

7.7.4. Understanding Formative Assessment

Initially, my understanding of formative assessment was limited, particularly regarding its theoretical underpinnings. Through each research cycle, my knowledge and comprehension of formative assessment's theoretical and practical aspects grew significantly. Engaging with the complexities and challenges of formative assessment has helped me develop more robust pedagogical practices that better support student

learning and engagement. Influenced by scholars such as (Yorke, 2003; Gikandi et al., 2011; Black, 2015; Morris et al., 2021; Kaya-Capocci et al., 2022), who noted the need for a deeper theoretical development in formative assessment, I have come to appreciate the intricacies involved. This journey revealed that effective formative assessment involves much more than just providing feedback; it requires an ongoing dialogue that influences student behaviour and learning strategies.

7.7.5. Educator Effort vs Efficiencies

My experience as a researcher and educator revealed that integrating TEFAs required a substantial investment of time and effort. Initially, I faced a steep learning curve, navigating new technologies and pedagogical strategies largely on my own. Engaging with professional groups, attending workshops, and utilising online resources became essential for developing the skills and understanding necessary to design effective formative assessments. The effort I put into designing quizzes, selecting the appropriate technology platforms, and aligning these tools with my course content led to noticeable improvements in student engagement and comprehension. Although the initial time commitment was significant, the efficiencies I gained over time justified this investment. The technology streamlined several aspects of my teaching process, from grading to providing timely feedback, which allowed me to focus more on instructional quality and student learning rather than on administrative tasks.

7.7.6. Enhanced Research Skills

Embarking on this project required a significant enhancement of my research skills. Designing and implementing a mixed-methods study, dealing with complex data sets, and navigating the intricacies of technology integration within education honed my abilities in both quantitative and qualitative research methodologies. This adaptability is a key characteristic of action research and has become a pivotal aspect of my approach to research, underscoring the importance of flexibility in the face of unforeseen challenges. Communicating the findings through writing this thesis and presenting at conferences has significantly developed my communication skills, allowing me to articulate complex ideas clearly and effectively.

7.7.7. Ethical Considerations in Technology Use

This research has deepened my awareness of the ethical complexities involved in the use of technology in education, particularly regarding data privacy and equitable access. As I implemented TEFAs, I became increasingly mindful of how students' personal

data was managed and the importance of respecting their privacy. Additionally, I recognised that technology's potential benefits could inadvertently widen gaps in educational access for students with limited resources or support, which in turn prompted me to consider how to ensure inclusivity in digital learning. These reflections also resonated with critiques in the literature that caution against uncritical assumptions of technology as a universally positive force in education (Selwyn, 2015; Watters, 2019). These experiences have enriched my understanding of the field, revealing both challenges and opportunities within educational technology and assessment. They emphasise the constantly changing nature of this area and the importance of continuous research into how technology, pedagogy, and learner diversity intersect. This enhanced understanding encourages me to take a more thoughtful and informed approach to the design and implementation of technology-enhanced educational practices.

7.8. Concluding Remarks

This thesis has undertaken a thorough examination of TEFAs within higher education, focusing on their impact on student engagement and learning outcomes. Recognising a gap in pedagogical practice, particularly for educators who come from non-educational backgrounds, this research aimed to explore the potential and limitations of integrating technology into educational settings. The findings highlight the promise of technology to enhance teaching and learning processes, contingent upon a deep understanding of its application. A central component of this research was the design, development, and iterative refinement of digital formative assessments. These tools were not simply add-ons but were thoughtfully integrated into existing curricular structures, enhancing the educational experience without overwhelming students and educators. The project's iterative nature allowed for continuous feedback, which was crucial in refining these tools to better meet the changing needs of both students and educators.

The dual focus of this research was, on the one hand, placed on enhancing student learning outcomes and, on the other hand, placed on contributing to my own professional development as an educator. The process of integrating technology into formative assessments provided valuable insights into effective educational practices and highlighted the transformative potential of technology in academic settings.

In the end, this journey proved to be about more than just implementing new tools; it involved understanding how these tools could fundamentally transform educational interactions and improve learning experiences. Through this research, a broader

question was addressed: how can technology be harnessed to foster more engaging and effective learning environments? This exploration was driven by my commitment to enhancing pedagogical strategies and the potential of technology to provide immediate, actionable feedback to students, thereby promoting a more engaged and reflective learning process. In conclusion, this research is expected to contribute significantly to the ongoing dialogue on optimising assessment practices in higher education through the effective integration of pedagogy, content, and technology. As technology and education continue to intersect, the insights from this study will be instrumental in enhancing teaching efficacy and student learning. Embracing the challenges and opportunities presented by technology-enhanced assessments allows educators and policymakers to ensure that educational practices not only keep pace with technological advancements but also lead to more engaging, inclusive, and effective learning environments.

Bibliography

Agnew, S., Kerr, J. and Watt, R. (2021) 'The effect on student behaviour and achievement of removing incentives to complete online formative assessments', *Australasian Journal of Educational Technology*, 37(4), pp. 173–185. Available at: https://doi.org/10.14742/ajet.6203.

Akinlolu, M., Makua, M. and Ngubane, N. (2024) *Online Teaching and Learning in Higher Education*, *Online Teaching and Learning in Higher Education*. Available at: https://doi.org/10.1007/978-3-031-56953-1.

Andrade, H.L. (2019) 'A Critical Review of Research on Student Self-Assessment', *Frontiers in Education*, 4(August), pp. 1–13. Available at: https://doi.org/10.3389/feduc.2019.00087.

Argyris, C. (1976) 'Single-Loop and Double-Loop Models in Research on Decision Making', *Administrative Science Quarterly*, 21(3), pp. 363–375. Available at: http://www.jstor.org/stable/2391848.

Argyris, C. (1977) 'Double Loop Learning in Organizations', *Harvard Business Review*, (September-October), pp. 115–126.

Assessment Reform Group (1999) *Assessment for Learning: Beyond the Black Box*. University of Cambridge: Faculty of Education, UK. Available at: http://www.aaia.org.uk/afl/assessment-reform-group/.

Assessment Reform Group (2002) *Testing, Motivation and Learning*. University of Cambridge: Faculty of Education, UK: Assessment Reform Group. Available at: http://www.aaia.org.uk/afl/assessment-reform-group/.

Van Barneveld, A., Arnold, K.E. and Campbell, J.P. (2012) *Analytics in Higher Education: Establishing a Common Language*, *EDUCAUSE Learning Initiative*. Available at: https://library.educause.edu/resources/2012/1/analytics-in-higher-education-establishing-a-common-language.

Bass, R. (2012) 'Disrupting Ourselves: The Problem of Learning in Higher Education', *Learning*, 36, pp. 1–17. Available at: https://net.educause.edu/ir/library/pdf/ERM1221.pdf%5Cnhttp://www.academiccolab.org/resources/webct_learningobjects.pdf.

Bearman, M. *et al.* (2014) *Guide to the Assessment Design Decisions Framework*. Available at: http://www.assessmentdecisions.org/guide.

Bearman, M., Nieminen, J.H. and Ajjawi, R. (2023) 'Designing assessment in a digital world: an organising framework', *Assessment and Evaluation in Higher Education*, 48(3), pp. 291–304. Available at: https://doi.org/10.1080/02602938.2022.2069674.

Bearman, M., Ryan, J. and Ajjawi, R. (2023) 'Discourses of artificial intelligence in higher education: a critical literature review', *Higher Education*, 86(2), pp. 369–385. Available at: https://doi.org/10.1007/s10734-022-00937-2.

Bennett, R.E. (2009) 'Formative Assessment: Can the Claims for Effectiveness Be Substantiated?', *Assessment in Education: Principles, Policy & Practice*, 18(1), pp. 5–25. Available at: http://www.tandfonline.com/doi/abs/10.1080/0969594X.2010.513678.

Bennett, R.E. (2011) 'Formative assessment: A critical review', *Assessment in Education: Principles, Policy and Practice*, 18(1), pp. 5–25. Available at: https://doi.org/10.1080/0969594X.2010.513678.

Bennett, S. *et al.* (2017) 'How technology shapes assessment design: Findings from a study of university teachers', *British Journal of Educational Technology*, 48(2), pp. 672–682. Available at: https://doi.org/10.1111/bjet.12439.

Berlin, I. (1998) *The Proper Study of Mankind: an Anthology of Essays*. London: Pimlico.

Bernard, H.R. (2011) 'Research methods in anthropology : qualitative and quantitative approaches', *Research methods in anthropology : qualitative and quantitative approaches* [Preprint]. 5th ed. Lanham, Md: AltaMira Press.

Biggs, J. (1996) 'Enhancing teaching through constructive alignment', *Higher Education*, 32, pp. 347–364.

Black, P. (2015) 'Formative assessment – an optimistic but incomplete vision', *Assessment in Education: Principles, Policy and Practice*, 22(1), pp. 161–177. Available at: https://doi.org/10.1080/0969594X.2014.999643.

Black, P. and Wiliam, D. (1998a) *Assessment and Classroom Learning*, *Assessment in Education: Principles, Policy & Practice*. Available at: https://doi.org/10.1080/0969595980050102.

Black, P. and Wiliam, D. (1998b) 'Inside the Black Box : Raising Standards Through Classroom Assessment', *Phi Delta Kappan*, 80, pp. 139–148. Available at: https://doi.org/10.1002/hrm.

Black, P. and Wiliam, D. (2009) 'Developing the theory of formative assessment', *Educational Assessment, Evaluation and Accountability*, 21(1), pp. 5–31. Available at: https://doi.org/10.1007/s11092-008-9068-5.

Blair, E., Maharaj, C. and Primus, S. (2016) 'Performance and perception in the flipped classroom', *Education and Information Technologies*, 21(6), pp. 1465–1482. Available at: https://doi.org/10.1007/s10639-015-9393-5.

Blondeel, E., Everaert, P. and Opdecam, E. (2022) 'Stimulating higher education students to use online formative assessments: the case of two mid-term take-home tests', *Assessment and Evaluation in Higher Education*, 47(2), pp. 297–312. Available at: https://doi.org/10.1080/02602938.2021.1908516.

Blondeel, E., Everaert, P. and Opdecam, E. (2023) 'Does practice make perfect? The effect of online formative assessments on students' self-efficacy and test anxiety', *British Accounting Review*, (January), p. 101189. Available at: https://doi.org/10.1016/j.bar.2023.101189.

Bloom, B.S., Hastings, J.T. and Madaus, G.F. (1971) *Handbook on formative and summative evaluation of student learning*, *Techniques*. McGraw-Hill Book Company. Available at: https://eric.ed.gov/?id=ED049304.

Bose, J. and Rengel, Z. (2009) 'A model formative assessment strategy to promote student-centered self-regulated learning in higher education', *US-China Education Review*, 6(12), pp. 29–35. Available at: https://eric.ed.gov/?id=ED511170.

Boud, D. (1995) *Enhancing Learning Through Self-assessment*, *Enhancing Learning Through Self-assessment*. London: Kogan Page.

Boud, D. (2000) 'Sustainable Assessment: Rethinking assessment for the learning society', *Studies in Continuing Education*, 22(2), pp. 151–167. Available at: https://doi.org/10.1080/713695728.

Brantley-Dias, L. and Ertmer, P.A. (2013) 'Goldilocks and TPACK: Is the construct "just right?"', *Journal of Research on Technology in Education*, 46(2), pp. 103–128. Available at: https://doi.org/10.1080/15391523.2013.10782615.

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualittaive Research in Psychology*, 3(2), pp. 77–101. Available at: https://psychology.ukzn.ac.za/?mdocs-file=1176.

Braun, V. and Clarke, V. (2013) 'Teaching thematic analysis: Overcoming challenges

and developing strategies for effective learning', *The Psychologist*, 26(2), pp. 120–123. Available at: https://doi.org/10.4135/9781412963909.n451.

Bree, R. and Gallagher, G. (2016) 'Using Microsoft Excel to code and thematically analyse qualitative data: a simple, cost-effective approach.', *All Ireland Journal of Teaching and Learning in Higher Education (AISHE-J)*, 8(2), pp. 2811–28114. Available at: http://ojs.aishe.org/index.php/aishe-j/article/view/[281].

Broadbent, J. *et al.* (2021) 'How does self-regulated learning influence formative assessment and summative grade? Comparing online and blended learners', *The Internet and Higher Education*, 50(April). Available at: https://doi.org/10.1016/j.iheduc.2021.100805.

Broadbent, J. (2021) *Self-regulated Learning Strategies in Online Higher Education*. Deakin University. Available at: https://doi.org/10779/DRO/DU:22565380.v1.

Brookfield, S.D. (2017) *Becoming a Critically Reflective Teacher*. 2nd Ed. John Wiley & Sons. Available at: https://search.proquest.com/legacydocview/EBC/4790372?accountid=12309.

Brookhart, S.M. (2008) 'Effective Feedback', *American Journal of Infection Control*, 37(5). Available at: https://doi.org/10.1016/j.ajic.2009.04.219.

Brophy, J. (1981) 'Teacher Praise: A Functional Analysis', *Review of Educational Research*, 51(1), pp. 5–32. Available at: https://doi.org/10.3102/00346543051001005.

Brown, S. (1999) 'Institutional Strategies for Asessment', in S. Brown and A. Glasner (eds) *Assessment Matters In Higher Educationn: Choosing and Using Diverse Approaches*. 1st Ed. The Society for Research into Higher Education & Open University Press, pp. 3–13. Available at: https://eric.ed.gov/?id=ED434545.

Bruner, J. (1961) 'The Act of Discovery', *Harvard Educational Review*, 31, pp. 21–32. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:The+Act+of+Discovery#0.

Brydon-Miller, M. and Maguire, P. (2009) 'Participatory action research: Contributions to the development of practitioner inquiry in education', *Educational Action Research*, 17(1), pp. 79–93. Available at: https://doi.org/10.1080/09650790802667469.

Brydon-Miller, M., Prudente, M. and Aguja, S. (2017) 'Educational Action Research

as Transformative Practice', in D. Wyse et al. (eds) *The BERA/SAGE Handbook of Educational Research*. Thousand Oaks, California: SAGE Publications, pp. 435–451. Available at: https://uk.sagepub.com/en-gb/eur/the-berasage-handbook-of-educational-research/book245556.

Bryman, A. (2008) 'Social Research Method, 3rd Ed.', *Oxford University Press* [Preprint].

Cain, M., Campbell, C. and Coleman, K. (2023) '"Kindness and empathy beyond all else": Challenges to professional identities of Higher Education teachers during COVID-19 times', *Australian Educational Researcher*, 50(4), pp. 1233–1251. Available at: https://doi.org/10.1007/s13384-022-00552-1.

Cain, T. (2011) 'Teachers' classroom-based action research', *International Journal of Research and Method in Education*, 34(1), pp. 3–16. Available at: https://doi.org/10.1080/1743727X.2011.552307.

Çakıroğlu, Ü. *et al.* (2016) 'International forum of educational technology & society exploring teaching programming online through web conferencing system: The lens of activity theory', *Journal of Educational Technology & Society*, 19(4), pp. 126–139.

Carless, D. (2007) 'Learning-oriented assessment: Conceptual bases and practical implications', *Innovations in Education and Teaching International*, 44(1), pp. 57–66. Available at: https://doi.org/10.1080/14703290601081332.

Carless, D. (2009) 'Trust, distrust and their impact on assessment reform', *Assessment and Evaluation in Higher Education*, 34(1), pp. 79–89. Available at: https://doi.org/10.1080/02602930801895786.

Carless, D. (2015a) *Excellence in University Assessment: Learning from Award-Winning Practice*. London: Routledge.

Carless, D. (2015b) 'Exploring learning-oriented assessment processes', *Higher Education*, 69(6), pp. 963–976. Available at: https://doi.org/10.1007/s10734-014-9816-z.

Carless, D. and Boud, D. (2018) 'The development of student feedback literacy: enabling uptake of feedback', *Assessment and Evaluation in Higher Education*, 43(8), pp. 1315–1325. Available at: https://doi.org/10.1080/02602938.2018.1463354.

Carless, D., Joughin, G. and Mok, M.M.C. (2006) 'Learning-oriented assessment: Principles and practice', *Assessment and Evaluation in Higher Education*, 31(4), pp.

395–398. Available at: https://doi.org/10.1080/02602930600679043.

Carr, W. and Kemmis, S. (1986) *Becoming critical: Education, knowledge, and action research*. London; Philadelphia: Falmer Press.

CCSSO (2008) *Attributes of effective formative assessment: A work product coordinated by Sarah McManus for the FAST SCASS, CCSSO.* Washington, DC: Council of Chief State School Officers.

CCSSO and FAST (2018) *Revising the definition of formative assessment*, *Formative Assessment for Students Teachers (FAST) State Collaborative on Assessment and Student Standards (SCASS)*. Available at: https://ccsso.org/resource-library/revising-definition-formative-assessment.

Charteris, J. and Thomas, E. (2017) 'Uncovering "unwelcome truths" through student voice: teacher inquiry into agency and student assessment literacy', *Teaching Education*, 28(2), pp. 162–177. Available at: https://doi.org/10.1080/10476210.2016.1229291.

Chen, Z., Jiao, J. and Hu, K. (2021) 'Formative Assessment as an Online Instruction Intervention: Student Engagement, Outcomes, and Perceptions', *International Journal of Distance Education Technologies*, 19(1), pp. 50–65. Available at: https://doi.org/10.4018/IJDET.20210101.oa1.

Chevalier, A., Dolton, P. and Lührmann, M. (2018) '"Making it count": incentives, student effort and performance', *Journal of the Royal Statistical Society. Series A: Statistics in Society*, 181(2), pp. 323–349. Available at: https://doi.org/10.1111/rssa.12278.

Chung, G.K.W.K., Shel, T. and Kaiser, W.J. (2006) 'An exploratory study of a novel online formative assessment and instructional tool to promote students' circuit problem solving', *Journal of Technology, Learning, and Assessment*, 5(6), pp. 1–26.

Clark, I. (2012) 'Formative Assessment: Assessment Is for Self-regulated Learning', *Educational Psychology Review*, 24(2), pp. 205–249. Available at: https://doi.org/10.1007/S10648-01.

Clarke, M. and Luna-Bazaldua, D. (2021) *Primer on Large-Scale Assessments of Educational Achievement*, *Primer on Large-Scale Assessments of Educational Achievement*. World Bank Group. Available at: https://doi.org/10.1596/978-1-4648-1659-8.

Coghlan, D. (2006) ‘Insider action research doctorates: Generating actionable knowledge’, *Higher Education*, 54(2), pp. 293–306. Available at: https://doi.org/10.1007/s10734-005-5450-0.

Coghlan, D. and Brannick, T. (2014) *Doing Action Research in Your Own Organisation*. 4th edn. London: SAGE Publications Ltd. Available at: https://study.sagepub.com/coghlanandbrannick.

Coghlan, D. and Casey, M. (2001) ‘Action research from the inside: issues and challenges in doing action research in your own hospital.’, *Journal of advanced nursing*, 35(5), pp. 674–82. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11529969.

Cohen, L., Manion, L. and Morrison, K. (2007) *Research Methods in Education*. 6th edn. EBSCOhost: Routledge.

Cohen, L., Manion, L. and Morrison, K. (2018a) ‘Action Research’, in *Research Methods in Education*. 8th Ed. Routeledge, pp. 153–161. Available at: https://doi.org/10.1177/1476750307083716.

Cohen, L., Manion, L. and Morrison, K. (2018b) ‘Bibliography’, in *Research Methods in Education*, pp. 855–906.

Coolahan, J. *et al.* (2017) *Better Future Better*. Irish Primary Principals Network and the National Association of Principals. Available at: https://mural.maynoothuniversity.ie/10001/.

Cooney, A. *et al.* (2023) ‘Not “just consumers of content”: early insights into the policy enactment of the Digital Learning Framework’, *Technology, Pedagogy and Education*, 32(4), pp. 457–472. Available at: https://doi.org/10.1080/1475939X.2023.2228320.

Corbin, J. and Strauss, A. (2008) *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. 3rd edn, *Basics of Qualitative Research Grounded Theory Procedures and Techniques*. 3rd edn. SAGE Publications Inc. Available at: https://doi.org/10.4135/9781452230153.

Coughlan, P. and Coghlan, D. (2002) ‘Action research for operations management’, *International Journal of Operations & Production Management*, 22(2), pp. 220–240. Available at: https://doi.org/10.1108/01443570210417515.

Credé, M., Roch, S.G. and Kieszczynka, U.M. (2010) ‘Class attendance in college: A

meta-analytic review of the relationship of class attendance with grades and student characteristics', *Review of Educational Research*, 80(2), pp. 272–295. Available at: https://doi.org/10.3102/0034654310362998.

Creswell, J.W. *et al.* (2007) 'Qualitative Research Designs: Selection and Implementation', *The Counseling Psychologist*, 35(2), pp. 236–264. Available at: https://doi.org/10.1177/0011000006287390.

Creswell, J.W. (2013) 'Research Design: Qualitative; Quantitative; and Mixed Methods Approaches', in *Research Design*. 4th edn. SAGE Publications, pp. 3–23. Available at: https://doi.org/45593:01.

Crisp, G.T. (2012) 'Integrative assessment: Reframing assessment practice for current and future learning', *Assessment and Evaluation in Higher Education*, 37(1), pp. 33–43. Available at: https://doi.org/10.1080/02602938.2010.494234.

Crisp, V. and Ward, C. (2008) 'The development of a formative scenario-based computer assisted assessment tool in psychology for teachers: The PePCAA project', *Computers and Education*, 50(4), pp. 1509–1526. Available at: https://doi.org/10.1016/j.compedu.2007.02.004.

Dadds, M. (2008) 'Empathetic validity in practitioner research', *Educational Action Research*, pp. 279–290. Available at: https://doi.org/10.1080/09650790802011973.

Dancer, D. and Kamvounias, P. (2005) 'Student involvement in assessment: A project designed to assess class participation fairly and reliably', *Assessment and Evaluation in Higher Education*, 30(4), pp. 445–454. Available at: https://doi.org/10.1080/02602930500099235.

Dann, R. (2014) 'Assessment as learning: Blurring the boundaries of assessment and learning for theory, policy and practice', *Assessment in Education: Principles, Policy and Practice*, 21(2), pp. 149–166. Available at: https://doi.org/10.1080/0969594X.2014.898128.

Davis, F.D.., Bagozzi, R.P.. and Warshaw, P.R.. (1989) 'User Acceptance of Computer Technology: A Comparison of Two Theoretical Models', *Management Science*, 35(8), pp. 982–1003. Available at: https://www.jstor.org/stable/2632151.

Davis, F.D. (1986) *A technology acceptance model for empirically testing new end-user information systems: theory and results*. Massachussetts Institute of technology. Available at: http://hdl.handle.net/1721.1/15192.

Davis, F.D. (1989) ‘Perceived usefulness, perceived ease of use, and user acceptance of information technology’, *MIS Quarterly: Management Information Systems*, 13(3), pp. 319–339. Available at: https://doi.org/10.2307/249008.

Dawson, P. *et al.* (2013) ‘Assessment Might Dictate the Curriculum, but What Dictates Assessment?’, *Teaching & Learning Inquiry*, 1(1), pp. 107–111. Available at: https://eric.ed.gov/?id=EJ1149734.

Dawson, P. *et al.* (2019) ‘What makes for effective feedback: staff and student perspectives’, *Assessment and Evaluation in Higher Education*, 44(1), pp. 25–36. Available at: https://doi.org/10.1080/02602938.2018.1467877.

Dempsey, M. (2016) *Exploring the impact of a key skills approach to teaching and learning in secondary education*. School of Education, Trinity College Dublin. Available at: http://hdl.handle.net/2262/85525.

DES (2004) *A Brief Description of the Irish Education System Education System*. Available at: www.education.ie.

DES (2008) *ICT in Schools*. Dublin. Available at: https://doi.org/10.4018/978-1-59904-949-6.ch236.

DES (2011) *National Strategy for Higher Education to 2030*. Available at: http://lenus.ie/hse/handle/10147/120285 (Accessed: 7 March 2014).

Dobson, J.L. (2008) ‘The use of formative online quizzes to enhance class preparation and scores on summative exams’, *American Journal of Physiology - Advances in Physiology Education*, 32(4), pp. 297–302. Available at: https://doi.org/10.1152/advan.90162.2008.

Dorling, D. (2013) ‘Using Statistics to Describe and Explore Data’, *Key Methods in Geography*, pp. 374–386.

Duff, A. and Mladenovic, R. (2015) ‘Antecedents and consequences of accounting students’ approaches to learning: A cluster analytic approach’, *The British Accounting Review*, 47(3), pp. 321–338. Available at: https://doi.org/https://doi.org/10.1016/j.bar.2014.06.003.

Dundalk IT Strategic Plan (2016) *Dundalk IT Strategic Plan 2017-2019*.

Dweck, C.S. (2007) ‘The Perils and Promises of Praise’, *Educational Leadership*, 65(2), pp. 34–39. Available at: https://doi.org/10.1037//0022-3514.75.1.33.

Earl, L. (2003) ‘Chapter 3: Assessment of Learning, for Learning, and as Learning’, in

Assessment as Learning: Using Classroom Assessment to Maximise Student Learning. 1st Ed. Thousand Oaks, CA: Corwin, pp. 21–28. Available at: https://www.google.ie/books/edition/Assessment_As_Learning/DbDEuqBsn-gC?hl=en&gbpv=1&dq=inauthor%3ALorna M. Earl&pg=PP1&printsec=frontcover.

Ebbutt, D. and Elliott, J. (1998) 'Practice-based Inquiry in the BETD In-service Programme - some key issues', *Journal for Educational Reform in Namibia*, 6(February). Available at: https://www.researchgate.net/publication/265045168%0APractice-based.

Einig, S. (2013) 'Supporting Students' Learning: The Use of Formative Online Assessments', *Accounting Education*, 22(5), pp. 425–444. Available at: https://doi.org/10.1080/09639284.2013.803868.

Eisenhart, M.A. (1991) 'Conceptual Frameworks for Research circa 1991: Ideas from a Cultural Anthropologist; Implications for Mathematics Education Researchers', in R.G. Underhill (ed.) *Proceeding of the Thirteen Annual Meeting of the American Paper of the International Group for the Psychology of Mathematics Education*. Virginia, USA: Blacksburg, pp. 202–219. Available at: https://nepc.colorado.edu/publication/conceptual-frameworks-research-circa-1991-ideas-a-cultural-anthropologist-implications-m.

Elliott, J. (1991) *Action Research for Educational Change*. 1st edn. Open University Press.

Elliott, J. (1998) *Curriculum Experiment: Meeting the Challenge of Social Change*. Open University Press.

Elliott, J. (2007) 'Assessing the quality of action research', *Research Papers in Education*, 22(2), pp. 229–246. Available at: https://doi.org/10.1080/02671520701296205.

Eschenbacher, S. and Fleming, T. (2020) 'Transformative dimensions of lifelong learning: Mezirow, Rorty and COVID-19', *International Review of Education*, 66(5), pp. 657–672. Available at: https://doi.org/10.1007/s11159-020-09859-6.

Farrelly, T. and Baker, N. (2023) 'Generative Artificial Intelligence: Implications and Considerations for Higher Education Practice', *Education Sciences*, 13(11). Available at: https://doi.org/10.3390/educsci13111109.

Fawns, T. (2022) 'An Entangled Pedagogy: Looking Beyond the Pedagogy—

Technology Dichotomy', *Postdigital Science and Education*, 4(3), pp. 711–728. Available at: https://doi.org/10.1007/s42438-022-00302-7.

Field, A. (2009) *Discovering Statistics Using SPSS*, *Sage Publication*. Available at: https://doi.org/10.1234/12345678.

Fisher, R., Cavanagh, J. and Bowles, A. (2011) 'Assisting transition to university: Using assessment as a formative learning tool', *Assessment and Evaluation in Higher Education*, 36(2), pp. 225–237. Available at: https://doi.org/10.1080/02602930903308241.

Fleckhammer, L. and Wise, L. (2010) 'Providing timely assignment feedback to large online student cohorts', *ASCILITE 2010 - The Australasian Society for Computers in Learning in Tertiary Education*, pp. 343–352. Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-84870732683&partnerID=tZOtx3y1.

Freire, P. (1972) *Pedagogy of the Oppressed*. Harmondsworth, Eng., New York: Penguin Education.

Freire, P. (2000) *Pedagogy of the Oppressed (30th Anniversary Edition)*. New York: Continuum International Publishing Group Inc.

Gaebel, M. *et al.* (2021) *Digitally enhanced learning and teaching in European higher education institutions*, *DIGI HE*. Available at: https://eua.eu/downloads/publications/digi-he survey report.pdf.

Gauntlett, N. (2007) 'Literature Review on Formative Assessment in Higher Education', *Framework* [Preprint], (November).

Gibbs, G. and Simpson, C. (2004) 'Conditions under which assessment supports students' learning', *Learning and Teaching in Higher Education*, 1, pp. 3–31. Available at: http://www.glos.ac.uk/adu/clt/lathe/issue1/index.cfm.

Gikandi, J.W., Morrow, D. and Davis, N.E. (2011) 'Online formative assessment in higher education: A review of the literature', *Computers & Education*, 57(4), pp. 2333–2351. Available at: https://doi.org/10.1016/j.compedu.2011.06.004.

Gordon, E.W. (2020) 'Toward Assessment in the Service of Learning', *Educational Measurement: Issues and Practice*, 39(3), pp. 72–78. Available at: https://doi.org/10.1111/emip.12370.

Grad, R.M. (2009) 'What's your epistemology? Think about it.', *Family medicine*,

41(5), pp. 356–7. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19418285.

Graham, C.R. (2011) 'Theoretical considerations for understanding technological pedagogical content knowledge (TPACK)', *Computers and Education*, 57(3), pp. 1953–1960. Available at: https://doi.org/10.1016/j.compedu.2011.04.010.

Granberg, C., Palm, T. and Palmberg, B. (2021) 'A case study of a formative assessment practice and the effects on students' self-regulated learning', *Studies in Educational Evaluation*, 68(August 2020). Available at: https://doi.org/10.1016/j.stueduc.2020.100955.

Grant, C. and Osanloo, A. (2014) 'Understanding, Selecting, and Integrating a Theoretical Framework in Dissertation Research: Creating the Blueprint for Your "House"', *Administrative Issues Journal Education Practice and Research*, 4(2), pp. 12–26. Available at: https://doi.org/10.5929/2014.4.2.9.

Greene, J.C., Carcelli, V.J. and Graham, W.F. (1989) 'Toward a Conceptual Framework for Mixed-Method Evaluation Designs', *Educationl Evaluation and Policy Analysis*, 11(3), pp. 255–274. Available at: https://doi.org/doi.org/10.2307/1163620.

Grundy, S. (1994) 'Action Research at the School Level: possibilities and problems', *Educational Action Research*, 2(April 2015), pp. 23–37. Available at: https://doi.org/10.1080/0965079940020103.

Grundy, S. (1997) 'Participatory Educational Research in Australia: The First Wave - 1976 to 1986', in R. McTaggart (ed.) *Participatory Action Research: International Contexts and Consequences*. Albany: State University of New York Press.

Guo, R. *et al.* (2013) 'Intelligent diagnostic feedback for online multiple-choice questions', *Artificial Intelligence Review*, 42(3), pp. 369–383. Available at: https://doi.org/10.1007/s10462-013-9419-6.

Hardiman, F. (2012) '"Finding a voice" The experience of mature students in a college of further education', (May).

Harks, B. *et al.* (2014) 'The effects of feedback on achievement, interest and self-evaluation: The role of feedback's perceived usefulness', *Educational Psychology*, 34(3), pp. 269–290. Available at: https://doi.org/10.1080/01443410.2013.785384.

Harlen, W. and James, M. (1997) 'Assessment and learning: Differences and relationships between formative and summative assessment', *International Journal of*

Phytoremediation, 21(1), pp. 365–379. Available at: https://doi.org/10.1080/0969594970040304.

Harrison, C. (2013) 'Collaborative action research as a tool for generating formative feedback on teachers classroom assessment practice: The KREST project', *Teachers and Teaching: Theory and Practice*, 19(2), pp. 209–220. Available at: https://doi.org/10.1080/13540602.2013.741839.

Harrison, C.J. *et al.* (2016) 'Factors influencing students' receptivity to formative feedback emerging from different assessment cultures', *Perspectives on Medical Education*, 5(5), pp. 276–284. Available at: https://doi.org/10.1007/s40037-016-0297-x.

Hart, S.G. (2006) 'Nasa-Task Load Index (NASA-TLX); 20 Years Later', *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 50(9), pp. 904–908. Available at: https://doi.org/10.1177/154193120605000909.

Hatten, R., Knapp, D. and Salonga, R. (1997) *Action research: comparison with the concepts of the reflective practitioner and quality assurance*, *Action Research Electronic Reader*. Available at: http://www.aral.com.au/arow/rdr.html (Accessed: 3 April 2017).

Hattie, J. (2007) *Effective Feedback*, *Government of South Australia: Let's Talk Assessment…*.

Hattie, J. and Jaeger, R. (1998) 'Assessment and classroom learning: A deductive approach', *International Journal of Phytoremediation*, 21(1), pp. 111–122. Available at: https://doi.org/10.1080/0969595980050107.

Hattie, J. and Timperley, H. (2007) 'The power of feedback', *Review of Educational Research*, 77(1), pp. 81–112. Available at: https://doi.org/10.3102/003465430298487.

Hattie, J. and Yates, G.C.R. (2013) *Visible learning and the science of how we learn*. 1st Ed. Milton Park, Abingdon, Oxon ; New York, NY: Routledge. Available at: https://doi.org/10.4324/9781315885025.

Hattie, J.A.C. (2009) *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. London: Routeledge.

HEA, H.E.A. (2015) *Effective feedback and uses of ISSE data: an emerging picture*.

HEFCE (2010) *HEFCE National Student Survey (2007-2010)*, *National Student Survey*. London, UK. Available at: http://www.hefce.ac.uk/ (Accessed: 26 April

2017).

Heil, J. and Ifenthaler, D. (2023) 'Online Assessment in Higher Education: A Systematic Review', *Online Learning Journal*, 27(1), pp. 187–218. Available at: https://doi.org/10.24059/olj.v27i1.3398.

Heinrich, E. *et al.* (2009) 'Recommendations for the use of e-tools for improvements around assignment marking quality', *Assessment and Evaluation in Higher Education*, 34(4), pp. 469–479. Available at: https://doi.org/10.1080/02602930802071122.

Heitink, M.C. *et al.* (2016) 'A systematic review of prerequisites for implementing assessment for learning in classroom practice', *Educational Research Review*, 17, pp. 50–62. Available at: https://doi.org/10.1016/j.edurev.2015.12.002.

Henderson, M., Ryan, T. and Phillips, M. (2019) 'The challenges of feedback in higher education', *Assessment and Evaluation in Higher Education*, 44(8), pp. 1237–1252. Available at: https://doi.org/10.1080/02602938.2019.1599815.

Hernández, R. (2012) 'Does continuous assessment in higher education support student learning?', *Higher Education*, 64(4), pp. 489–502. Available at: https://doi.org/10.1007/s.

Higher Education Authority (2019) *Digital Transformation and Empowering Technologies in Higher Education*.

Higley, M. (2016) 'Why Meaningful Online Feedback Is Important - eLearning Industry', *Http://Elearningindustry.Com* [Preprint]. Available at: http://elearningindustry.com/meaningful-online-feedback-important.

Hitchcock, G. and Hughes, D. (1995) *Research and the Teacher: A Qualitative Introduction to School-based Research*. 2nd edn. London: Routledge.

Hogan, P., Brosnan, A. and DeRóiste, B. (2007) *Learning Anew*, *Teaching and Learning for the 21st Century*. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:LEARNING+ANEW#4 (Accessed: 7 March 2014).

Hooda, M. *et al.* (2022) 'Artificial Intelligence for Assessment and Feedback to Enhance Student Success in Higher Education', *Mathematical Problems in Engineering*, 2022. Available at: https://doi.org/10.1155/2022/5215722.

Hopkins, D. (1993) *A teacher's guide to classroom research*. 2nd Ed. Buckingham, England: Open University Press. Available at: https://go.exlibris.link/NNQHwp81.

Ingleby, E. (2012) 'Research methods in education', *Professional Development in Education*, pp. 507–509. Available at: https://doi.org/10.1080/19415257.2011.643130.

INTO (2016) *Teaching in the 21st Century: 100 Years of Teaching 1916-2016*. Discussion. Irish National Teachers' Organisation. Available at: https://www.into.ie/app/uploads/2019/07/Teachinginthe21stCentury_Web.pdf.

Irons, A. (2008) *Enhancing Learning through Formative Assessment and Feedback*. 1st Ed., *Religious Education in the Secondary School*. 1st Ed. New York: Routeledge. Available at: https://doi.org/10.4324/9781003211617-6.

Jeff Haywood *et al.* (2014) *The Changing Pedagogical Landscape: New ways of teaching and learning and their implications for higher education policy - Executive Summary* -. Available at: https://doi.org/10.2766/57677.

JISC (2009) *Effective Practice in a Digital Age: A guide to technology-enhanced learning and teaching*. Bristol, England. Available at: http://hdl.voced.edu.au/10707/185935 (Accessed: 24 March 2014).

JISC (2016) *Transforming assessment and feedback with technology*. Available at: https://www.jisc.ac.uk/full-guide/transforming-assessment-and-feedback.

Jootun, D., McGhee, G. and Marland, G.R. (2009) 'Reflexivity: promoting rigour in qualitative research', *Nursing standard*, 23(23), p. 42.

Jordan, S. (2009) 'Assessment for learning: pushing the boundaries of computer-based assessment', *Practitioner Research in Higher Education*, (1971), pp. 11–19. Available at: http://194.81.189.19/ojs/index.php/prhe/article/view/29 (Accessed: 31 May 2014).

Jump, L. (2011) 'Why university lecturers enhance their teaching through the use of technology: A systematic review', *Learning, Media and Technology*, 36(1), pp. 55–68. Available at: https://doi.org/10.1080/17439884.2010.521509.

Juwah, C. *et al.* (2004) 'Enhancing student learning through effective formative feedback', *Higher Education*, June(68), pp. 1–41. Available at: http://www.heacademy.ac.uk/resources/detail/resource_database/id353_effective_formative_feedback_juwah_etal.

Kahu, E.R. (2013) 'Framing student engagement in higher education', *Studies in Higher Education*, 38(5), pp. 758–773. Available at: https://doi.org/10.1080/03075079.2011.598505.

Kaya-Capocci, S., O'Leary, M. and Costello, E. (2022) 'Towards a Framework to

Support the Implementation of Digital Formative Assessment in Higher Education', *Education Sciences*, 12(11). Available at: https://doi.org/10.3390/educsci12110823.

Kemmis, S. (2009) 'Action research as a practice-based practice', *Educational Action Research*, 17(3), pp. 463–474. Available at: https://doi.org/10.1080/09650790903093284.

Kemmis, S. and McTaggart, R. (1988) *The Action Research Planner*. 3rd Ed. Deakin University Press. Available at: https://trove.nla.gov.au/version/44948925.

Kennedy, E. *et al.* (2015) 'Making meaningful decisions about time, workload and pedagogy in the digital age: the Course Resource Appraisal Model', *Distance Education*, 36(2), pp. 177–195. Available at: https://doi.org/10.1080/01587919.2015.1055920.

Kennedy, M. and Dunn, T.J. (2018) 'Improving the Use of Technology Enhanced Learning Environments in Higher Education in the UK: A Qualitative Visualization of Students' Views', *Contemporary Educational Technology*, 9(1), pp. 76–89. Available at: https://doi.org/10.30935/cedtech/6212.

Keppell, M. and Carless, D. (2006) 'Learning-oriented assessment: A technology-based case study', *Assessment in Education: Principles, Policy and Practice*, 13(2), pp. 179–191. Available at: https://doi.org/10.1080/09695940600703944.

Kibble, J. (2007) 'Use of unsupervised online quizzes as formative assessment in a medical physiology course: Effects of incentives on student participation and performance', *American Journal of Physiology - Advances in Physiology Education*, 31(3), pp. 253–260. Available at: https://doi.org/10.1152/advan.00027.2007.

Kiersey, R.A., Devitt, A. and Brady, M. (2018) *Staff Use of Technology-Enhanced Assessment in Higher Education: A Systematic Review*. Trinity College Dublin. Available at: https://doi.org/10.6084/m9.figshare.7182467.

King, E. and Boyatt, R. (2015) 'Exploring factors that influence adoption of e-learning within higher education', *British Journal of Educational Technology*, 46(6), pp. p1272-1280. Available at: https://doi.org/https://doi.org/10.1111/bjet.12195.

Kingston, N. and Nash, B. (2011) 'Formative Assessment : A Meta-Analysis and a Call for Research', *Educational Measurement: Issues and Practice*, 30(4), pp. 28–37. Available at: https://doi.org/10.1111/j.1745-3992.2011.00220.x.

Kirkwood, A. and Price, L. (2013a) 'Examining some assumptions and limitations of

research on the effects of emerging technologies for teaching and learning in higher education', *British Journal of Educational Technology*, 44(4), pp. 536–543. Available at: https://doi.org/10.1111/bjet.12049.

Kirkwood, A. and Price, L. (2013b) 'Missing: evidence of a scholarly approach to teaching and learning with technology in higher education', *Teaching in Higher Education*, 18(3), pp. 327–337. Available at: https://doi.org/10.1080/13562517.2013.773419.

Kirkwood, A. and Price, L. (2014) 'Technology-enhanced learning and teaching in higher education: what is "enhanced" and how do we know? A critical literature review', *Learning, Media and Technology*, 39(1), pp. 6–36. Available at: https://doi.org/10.1080/17439884.2013.770404.

Kluger, A.N. and DeNisi, A. (1996) 'The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory', *Psychological Bulletin*, 119(2), pp. 254–284. Available at: https://doi.org/10.1037/0033-2909.119.2.254.

Knight, P. and Yorke, M. (2003) *Assessment Learning and Employability*. The Society for Research into Higher EducationOpen University Press.

Koehler, M.J. and Mishra, P. (2009) 'What is Technological Pedagogical Content Knowledge?', *Contemporary Issues in Technology and Teacher Education*, 9(1), pp. 60–70. Available at: https://doi.org/10.1177/002205741319300303.

Koehler, M.J., Mishra, P. and Cain, W. (2013) 'What Is Technological Pedagogical Content Knowledge (TPACK)?', *Journal of Education*, 193(3), pp. 13–19.

Koh, L.C. (2008) 'Refocusing formative feedback to enhance learning in pre-registration nurse education', *Revista Espanola de Cirugia Ortopedica y Traumatologia*, 52(4), pp. 223–230. Available at: https://doi.org/10.1016/j.nepr.2007.08.002.

Krishnan, J. (2023) 'Implementation of Technology Enhanced Formative Assessments in 21st Century Education', *International Journal of Asian Education*, 4(4), pp. 212–222. Available at: https://doi.org/10.46966/ijae.v4i4.308.

Krueger, R.A. (1988) 'Focus groups : a practical guide for applied research', *Focus groups : a practical guide for applied research* [Preprint]. Newbury Park, Calif: Sage Publications.

Kyllonen, P.C. and Sevak, A. (2024) *Charting the Future of Assessments*. Available at: https://www.pt.ets.org/research/charting-the-future-of-assessments.html.

van Laar, E. *et al.* (2020) 'Determinants of 21st-Century Skills and 21st-Century Digital Skills for Workers: A Systematic Literature Review', *SAGE Open*, 10(1). Available at: https://doi.org/10.1177/2158244019900176.

Lam, R. (2016) 'Assessment as learning: examining a cycle of teaching, learning, and assessment of writing in the portfolio-based classroom', *Studies in Higher Education*, 41(11), pp. 1900–1917. Available at: https://doi.org/10.1080/03075079.2014.999317.

Landl, E. and Wylie, C. (2024) *Understanding Assessment Culture*. Available at: https://www.nciea.org/library/understanding-assessment-culture/.

de Lange, P., Suwardy, T. and Mavondo, F. (2003) 'Integrating a virtual learning environment into an introductory accounting course: Determinants of student motivation', *Accounting Education*, 12(1), pp. 1–14. Available at: https://doi.org/10.1080/0963928032000064567.

Laugwitz, B., Held, T. and Schrepp, M. (2007) 'Construction and Evaluation of a User Experience Questionnaire', *Lecture Notes in Computer Science (LNCS), Springer*, (4), p. 2007. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.472.3719&rep=rep1&type=pdf.

Laurillard, D. (2007) 'Modelling Benefits-Oriented Costs for Technology Enhanced Learning', *Higher Education*, 54(1), pp. 21–39. Available at: https://doi.org/10.1007/sl0734-006-9044-2.

Laurillard, D. (2008) 'Technology Enhanced Learning as a Tool for Pedagogical Innovation', *Journal of Philosophy of Education*, 42(3), pp. 521–533. Available at: https://doi.org/10.1111/j.1467-9752.2008.00658.x.

Laurillard, D. (2009) 'The pedagogical challenges to collaborative technologies', *Computer-Supported Collaborative Learning*, 4(5), pp. 5–20. Available at: https://doi.org/10.1007/s11412-008-9056-2.

Learnosity (2023) *A guide to AI & assessment*.

Leenknecht, M. *et al.* (2021) 'Formative assessment as practice: the role of students' motivation', *Assessment and Evaluation in Higher Education*, 46(2), pp. 236–255. Available at: https://doi.org/10.1080/02602938.2020.1765228.

Lewin, K. (1943) ‘Psychology and the Process of Group Living’, *Journal of Social Psychology*, 17(1), pp. 113–131. Available at: https://doi.org/10.1080/00224545.1943.9712269.

Light, R. (2008) ‘Complex Learning Theory-Its Epistemology and Its Assumptions About Learning: Implications for Physical Education.’, *Journal of Teaching in Physical Education*, 27(1), pp. 21–37. Available at: http://search.ebscohost.com/login.aspx?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=02735024&AN=28094571&h=VcmTv9UAUapgFBi2oazd5LZ6P17/koeJBtcyskPO4Yo4vMQKlcYYCy/xl9Rjvw7BTfFszo9FCn0oA+dnkFgKvQ==&crl=c (Accessed: 24 March 2014).

Looney, J. (2019) ‘Digital Formative Assessment: A review of the literature’, *European Comission* [Preprint], (September). Available at: http://www.eun.org/documents/411753/817341/Assess%40Learning+Literature+Review/be02d527-8c2f-45e3-9f75-2c5cd596261d.

Luft, J. and Ingham, H. (1961) ‘The Johari Window: A Graphic Model of Awareness in Interpersonal Relations’, *Human Relations Training News*, 5(9), pp. 6–7.

Maguire, P. (1987) *Doing Participatory Research: A Feminist Approach*. Amherst: Center for International Education, School of Education, University of Massachusetts.

Maier, U., Wolf, N. and Randler, C. (2016) ‘Effects of a computer-assisted formative assessment intervention based on multiple-tier diagnostic items and different feedback types’, *Computers and Education*, 95, pp. 85–98. Available at: https://doi.org/10.1016/j.compedu.2015.12.002.

Major, C.H. (2015) ‘Student Engagement’, in *Teaching Online: A Guide to Theory, Research, and Practice*. Johns Hopkins University Press. Available at: https://doi.org/10.4135/9781529714395.n537.

Malau-Aduli, B.S. *et al.* (2014) ‘Using computer-based technology to improve feedback to staff and students on MCQ assessments’, *Innovations in Education and Teaching International*, 51(5), pp. 510–522. Available at: https://doi.org/10.1080/14703297.2013.796711.

Marín, V.I., De Benito, B. and Darder, A. (2020) ‘Technology-Enhanced Learning for Student Agency in Higher Education: a Systematic Literature Review’, *Interaction Design and Architecture(s) Journal*, 45, pp. 15–49. Available at:

https://doi.org/10.55612/s-5002-045-001.

McAleese, M. and Vassiliou, A. (2014) *High Level Group on the Modernisation of Higher Education*. Luxembourg. Available at: https://doi.org/10.2766/42468.

McCallum, S. and Milner, M.M. (2021) 'The effectiveness of formative assessment: student views and staff reflections', *Assessment and Evaluation in Higher Education*, 46(1), pp. 1–16. Available at: https://doi.org/10.1080/02602938.2020.1754761.

McGarr, O. (2009) 'The development of ICT across the curriculum in Irish schools: A historical perspective', *British Journal of Educational Technology*, 40(6), pp. 1094–1108. Available at: https://doi.org/10.1111/j.1467-8535.2008.00903.x.

McKernan, J. (1996) 'Curriculum action research : a handbook of methods and resources for the reflective practitioner', *Curriculum action research : a handbook of methods and resources for the reflective practitioner* [Preprint]. 2nd ed. London: Kogan Page.

McNiff, J. (2002) *Action research for professional development: Concise advice for new action researchers*. 3rd Ed.

McNiff, J. and Whitehead, J. (2011) *All You Need To Know About Action Research*. 2nd Ed, *Book*. 2nd Ed. SAGE Publications Ltd.

McTaggart, R. (1997a) 'Guiding Principles for Participatory Action Research', in R. McTaggart (ed.) *Participatory Action Research*. State University of New York Press. Available at: https://search.proquest.com/legacydocview/EBC/3406999/bookReader?accountid=12309&ppg=22.

McTaggart, R. (1997b) *Participatory Action Research: International Contexts and Consequences*. State University of New York Press, Albany, Available from: ProQuest Ebook Central. Available at: https://search.proquest.com/legacydocview/EBC/3406999?accountid=12309.

Mercer, M. and Gulseren, D.B. (2024) 'When negative feedback harms: a systematic review of the unintended consequences of negative feedback on psychological, attitudinal, and behavioral responses', *Studies in Higher Education*, 49(4), pp. 654–669. Available at: https://doi.org/10.1080/03075079.2023.2248490.

Mezirow, J. (1991) *Transformative Dimensions of Adult Learning*, *The JosseyBass higher and adult education series*.

Miller, T. (2009) ‘Formative computer-based assessment in higher education: the effectiveness of feedback in supporting student learning’, *Assessment & Evaluation in Higher Education*, 34(2), pp. 181–192. Available at: https://doi.org/10.1080/02602930801956075.

Mo, S. (2011) ‘Evidence on Instructional Technology and Student Engagement in an Auditing Course’, *Academy of Educational Leadership Journal*, 15(4), pp. 149–159. Available at: https://www.proquest.com/openview/745d1912cdd9d8033032f828e6147160.

Molloy, E. and Boud, D. (2013) ‘Seeking a different angle on feedback in clinical education: the learner as seeker, judge and user of performance information.’, *Medical education*, 47(3), pp. 227–9. Available at: https://doi.org/10.1111/medu.12116.

Molloy, E., Boud, D. and Henderson, M. (2020) ‘Developing a learning-centred framework for feedback literacy’, *Assessment and Evaluation in Higher Education*, 45(4), pp. 527–540. Available at: https://doi.org/10.1080/02602938.2019.1667955.

Morgan, D.L. (1997) ‘Focus groups as qualitative research’. Thousand Oaks, Calif: Sage Publications (Qualitative research methods series ; v. 16).

Morris, R., Perry, T. and Wardle, L. (2021) ‘Formative assessment and feedback for learning in higher education: A systematic review’, *Review of Education*, 9(3), pp. 1–26. Available at: https://doi.org/10.1002/rev3.3292.

Mouly, G.J. (1978) *Educational Research: The Art and Science of Investigation*. 3rd Editio. Allyn and Bacon.

Murchan, D. and Shiel, G. (2024) *Understanding & Applying Assessment in Education*. 2nd Ed. London: Sage Publications Ltd.

Murphy, D.H., Little, J.L. and Bjork, E.L. (2023) ‘The Value of Using Tests in Education as Tools for Learning — Not Just for Assessment’, *Educational Psychology Review*, 35(89), pp. 1–21. Available at: https://doi.org/10.1007/s10648-023-09808-3.

Nancekivell, S.E., Shah, P. and Gelman, S.A. (2020) ‘Maybe they’re born with it, or maybe it’s experience: Toward a deeper understanding of the learning style myth’, *Journal of Educational Psychology*, 112(2), pp. 221–235. Available at: https://doi.org/10.1037/edu0000366.

New South Wales Department of Education and Training (2010) ‘Action Research in Education: Guidelines’, *Action Research in Education (Guidelines)*. 2nd Ed.

Professional Learning and Leadership Development Directorate, pp. 1–4. Available at: https://doi.org/10.1080/14767333.2013.874780.

NFETL (2014) *Building digital capacity in higher education:Principles and First Insights from the Sectoral Consultation on Building Digital Capacity in Irish Higher Education*. Dublin. Available at: https://www.teachingandlearning.ie/wp-content/uploads/2014/05/Digital-Roadmap-PHASE1MAY282014.pdf.

NFETL (2015) *Teaching and learning in Irish higher education: A roadmap for enhancement in a digital world 2015-2017*, *Teachingandlearning.Ie*. Available at: http://www.teachingandlearning.ie/wp-content/uploads/2015/03/Digital-Roadmap-web.pdf.

NFETL (2017) *Expanding our Understanding of Assessment and Feedback in Irish Higher Education*. Available at: https://www.teachingandlearning.ie/wp-content/uploads/2017/03/Sectoral-insight-web-ready.pdf.

NFETL (2018) *Forum Insight Suggestions on how to involve students in Assessment OF / FOR / AS Learning*. Available at: https://doi.org/10.6084/m9.figshare.4487762.

Nguyen, Q., Huptych, M. and Rienties, B. (2018) 'Using Temporal Analytics to Detect Inconsistencies between Learning Design and Student Behaviours', *Journal of Learning Analytics*, 5(3), pp. 120–135. Available at: https://doi.org/10.18608/jla.2018.53.8.

Ní Shé, C., Ní Fhloinn, E. and Mac an Bhaird, C. (2023) 'Student Engagement with Technology-Enhanced Resources in Mathematics in Higher Education: A Review', *Mathematics*. MDPI. Available at: https://doi.org/10.3390/math11030787.

NicFhlannchadha, S. (2022) 'The Results of the StudentSurvey.ie Trends Over Time Research, 2016-2021', *Aishe-J*, 14(1), pp. 2016–2021.

Nicol, D. (2006) 'Increasing success in first year courses: Assessment re-design, self-regulation and learning technologies', in *ASCILITE 2006 - The Australasian Society for Computers in Learning in Tertiary Education*, pp. 589–598.

Nicol, D. (2007) 'Principles of good assessment and feedback: Theory and practice', in *REAP International Online Conference on Assessment Design for Learner Responsibility*. REAP. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Principles+of+good+assessment+and+feedback+:+Theory+and+practice#1 (Accessed: 26 May 2014).

Nicol, D. (2009) 'Assessment for learner self-regulation: Enhancing achievement in the first year using learning technologies', *Assessment and Evaluation in Higher Education*, 34(3), pp. 335–352. Available at: https://doi.org/10.1080/02602930802255139.

Nicol, D. (2010) 'From monologue to dialogue: Improving written feedback processes in mass higher education', *Assessment and Evaluation in Higher Education*, 35(5), pp. 501–517. Available at: https://doi.org/10.1080/02602931003786559.

Nicol, D. (2021) 'The power of internal feedback: exploiting natural comparison processes', *Assessment and Evaluation in Higher Education*, 46(5), pp. 756–778. Available at: https://doi.org/10.1080/02602938.2020.1823314.

Nicol, D. and Macfarlane-Dick, D. (2004) 'Rethinking formative assessment in HE: a theoretical model and seven principles of good feedback practice', *Higher Education Academy* [Preprint]. Available at: http://www.heacademy.ac.uk/assets/was York - delete this soon/documents/ourwork/assessment/web0015_rethinking_formative_assessment_in_he.pdf (Accessed: 26 May 2014).

Nicol, D. and MacFarlane-Dick, D. (2006) 'Formative assessment and self-regulated learning: A model and seven principles of good feedback practice', *Studies in Higher Education*, 31(2), pp. 199–218. Available at: https://doi.org/10.1080/03075070600572090.

Nicol, D. and Milligan, C. (2006) 'Rethinking technology-supported assessment practices in relation to the seven principles of good feedback practice', in C. Bryan and K. Clegg (eds) *Innovative Assessment in Higher Education: A Handbook for Academic Practitionersnicol*. London and New York: Routeledge, Taylor and Francis Group Ltd, pp. 64–77. Available at: https://doi.org/10.4324/9780203969670.

Nietzsche, F.W. (2006) *Thus Spoke Zarathustra: A Book for All and None*. Edited by A. Del Caro and R. Pippin. Cambridge: Cambridge University Press. Available at: https://assets.cambridge.org/97805216/02617/copyright/9780521602617_copyright.pdf.

Noffke, S.E. (1997) 'Chapter 6: Professional, Personal, and Political Dimensions of Action Research', *Review of Research in Education*, 22(1), pp. 305–343. Available at: https://doi.org/10.3102/0091732X022001305.

Oppenheim, A.N. (1992) 'Questionnaire design, interviewing, and attitude measurement', *Questionnaire design, interviewing, and attitude measurement* [Preprint]. New ed. London ; Pinter Publishers.

Panadero, E. *et al.* (2019) 'Using formative assessment to influence self- and co-regulated learning: the role of evaluative judgement', *European Journal of Psychology of Education*, 34(3), pp. 535–557. Available at: https://doi.org/10.1007/s10212-018-0407-8.

Pashler, H. *et al.* (2009) 'Learning Styles Concepts', *Journal of the association for psychological science*, 9(3), pp. 105–119.

Pereira de Sousa, B.F. (2018) 'Engaging students in the evaluation process using co-creation and technology enhanced learning (CC-TEL)', *CEUR Workshop Proceedings*, 2190.

Perera, L., Nguyen, H. and Watty, K. (2014) 'Formative Feedback through Summative Tutorial-based Assessments: The Relationship to Student Performance', *Accounting Education*, 23(5), pp. 424–442. Available at: https://doi.org/10.1080/09639284.2014.947093.

Phelps, R. and Graham, A. (2010) 'Exploring the complementarities between complexity and action research: The story of Technology Together', *Cambridge Journal of Education*, 40(2), pp. 183–197. Available at: https://doi.org/10.1080/0305764X.2010.481259.

Piggot-Irvine, E., Rowe, W. and Ferkins, L. (2015) 'Conceptualizing indicator domains for evaluating action research', *Educational Action Research*, 23(4), pp. 545–566. Available at: https://doi.org/10.1080/09650792.2015.1042984.

Pine, G.J. (2009) 'Teacher Action Research: Collaborative, Participatory, and Democratic Inquiry', in *Teacher Action Research: Building Knowledge Democracies*. SAGE Publications Inc., pp. 29–62. Available at: https://doi.org/http://dx.doi.org/10.4135/9781452275079.

Polly, D., Martin, F. and Guilbaud, T.C. (2021) 'Examining barriers and desired supports to increase faculty members' use of digital technologies: perspectives of faculty, staff and administrators', *Journal of Computing in Higher Education*, 33(1), pp. 135–156. Available at: https://doi.org/10.1007/s12528-020-09259-7.

Price, M. *et al.* (2010) 'Feedback: All that effort, but what is the effect?', *Assessment*

& Evaluation in Higher Education, 35(3), pp. 277–289. Available at: https://doi.org/10.1080/02602930903541007.

Pryor, J. and Crossouard, B. (2008) 'A socio-cultural theorisation of formative assessment', *Oxford Review of Education*, 34(1), pp. 1–20. Available at: https://doi.org/10.1080/03054980701476386.

Pryor, J. and Crossouard, B. (2010) 'Challenging formative assessment: Disciplinary spaces and identities', *Assessment and Evaluation in Higher Education*, 35(3), pp. 265–276. Available at: https://doi.org/10.1080/02602930903512891.

Race, P. (2007) *The lecturer's toolkit : a practical guide to assessment, learning and teaching*. 3rd ed. London: Routledge.

Rahiman, H.U. and Kodikal, R. (2024) 'Revolutionizing education: Artificial intelligence empowered learning in higher education', *Cogent Education*, 11(1). Available at: https://doi.org/10.1080/2331186X.2023.2293431.

Ramaprasad, A. (1983) 'On the Definition of Feedback', *Behavioral Science ; . Vol. 28, Iss. 1, (Jan 1, 1983): 4.*, 28(1), pp. 4–13. Available at: https://doi.org/0005-7940.

Redecker, C. and Johannessen, Ø. (2013) 'Changing Assessment - Towards a New Assessment Paradigm Using ICT', *European Journal of Education*, 48(1), pp. 79–96. Available at: https://doi.org/10.1111/ejed.12018.

Rhew, E. *et al.* (2018) 'The effects of a growth mindset on self-efficacy and motivation', *Cogent Education*, 5(1), pp. 1–16. Available at: https://doi.org/10.1080/2331186X.2018.1492337.

Roberts, D.F. and Foehr, U.G. (2008) 'Trends in Media Use', *The Future of children*, 18(1), pp. 11–37. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21338004.

Rushton, A. (2005) 'Formative assessment: a key to deep learning?', *Medical Teacher*, 27(6), pp. 509–513. Available at: https://doi.org/10.1080/01421590500129159.

Ryan, B., McGarr, O. and McCormack, O. (2020) 'Underneath the veneer of techno-positivity–exploring teachers' perspectives on technology use in Further Education and Training', *Teachers and Teaching: Theory and Practice*, 26(5–6), pp. 414–427. Available at: https://doi.org/10.1080/13540602.2020.1863207.

Ryan, T. *et al.* (2024) 'Feedback in higher education: aligning academic intent and student sensemaking', *Teaching in Higher Education*, 29(4), pp. 860–875. Available

at: https://doi.org/10.1080/13562517.2022.2029394.

Sadler, D.R. (1989) 'Formative assessment and the design of instructional systems', *Instructional Science*, 18(2), pp. 119–144. Available at: https://www.jstor.org/stable/23369143.

Sadler, D.R. (1998) 'Formative Assessment: revisiting the territory', *Assessment in Education: Principles, Policy & Practice*, 5(February 2015), pp. 77–84. Available at: https://doi.org/10.1080/0969595980050104.

Sadler, D.R. (2010) 'Beyond feedback: developing student capability in complex appraisal', *Assessment & Evaluation in Higher Education*, 35(5), pp. 535–550. Available at: https://doi.org/10.1080/02602930903541015.

Sarter, M. (2006) 'The consequences of atheoretical, task-driven experimentation: Theoretical comment on Paban, Chambon, Jaffard, and Alescio-Lautier (2005)', *Behavioral Neuroscience*, 120(2), pp. 493–495. Available at: https://doi.org/10.1037/0735-7044.120.2.493.

Schaffer, H.E. *et al.* (2017) 'Automating individualized formative feedback in large classes based on a directed concept graph', *Frontiers in Psychology*, 8(FEB), pp. 1–11. Available at: https://doi.org/10.3389/fpsyg.2017.00260.

Scriven, M. 1967. (1966) 'The methodology of evaluation', *Social Science Consortium*, Mar(110).

Secretary of Defense Donald H. Rumsfeld (2002) *DoD News Briefing - Secretary Rumsfeld and Gen. Myers*. Available at: http://www.defense.gov/transcripts/transcript.aspx?transcriptid=2636 (Accessed: 16 May 2014).

Selwyn, N. (2008) 'From state-of-the-art to state-of-the-actual? Introduction to a special issue', *Technology, Pedagogy and Education*, 17(2), pp. 83–87. Available at: https://doi.org/10.1080/14759390802098573.

Selwyn, N. (2011) 'Editorial: In praise of pessimism — the need for negativity in educational technology', *British Journal of Educational Technology*, 42(5), pp. 713–718. Available at: https://doi.org/10.1111/j.1467-8535.2011.01215.x.

Selwyn, N. (2012) 'Ten suggestions for improving academic research in education and technology', *Learning, Media and Technology*, 37(3), pp. 213–219. Available at: https://doi.org/10.1080/17439884.2012.680213.

Selwyn, N. (2015) ‘Technology and Education—Why It’s Crucial to be Critical’, in *Critical Perspectives on Technology and Education*.

Selwyn, N. *et al.* (2020) ‘What’s next for Ed-Tech? Critical hopes and concerns for the 2020s’, *Learning, Media and Technology*, 45(1), pp. 1–6. Available at: https://doi.org/10.1080/17439884.2020.1694945.

Selwyn, N. *et al.* (2021) ‘Digital Technologies and the Automation of Education — Key Questions and Concerns’, *Postdigital Science and Education*, 5(1), pp. 15–24. Available at: https://doi.org/10.1007/s42438-021-00263-3.

Shepard, L.A. (2008) ‘Formative Assessment: Caveat Emptor’, in C.A. Dwyer (ed.) *The Future of Assessment*. 1st Editio. New York: Routledge, p. 25. Available at: https://www.taylorfrancis.com/chapters/edit/10.4324/9781315086545-12/formative-assessment-caveat-emptor-lorrie-shepard.

Shepard, L.A., Penuel, W.R. and Pellegrino, J.W. (2018) ‘Using Learning and Motivation Theories to Coherently Link Formative Assessment, Grading Practices, and Large-Scale Assessment’, *Educational Measurement: Issues and Practice*, 37(1), pp. 21–34. Available at: https://doi.org/10.1111/emip.12189.

Shute, V.J. (2008) ‘Focus on formative feedback’, *Review of Educational Research*, 78(1), pp. 153–189. Available at: https://doi.org/10.3102/0034654307313795.

Sim, G., Holifield, P. and Brown, M. (2004) ‘Implementation of computer assisted assessment: lessons from the literature’, *Alt-J*, 12(3), pp. 215–229. Available at: https://doi.org/10.1080/0968776042000259546.

Slade, C. *et al.* (2022) ‘Insights into how academics reframed their assessment during a pandemic: disciplinary variation and assessment as afterthought’, *Assessment and Evaluation in Higher Education*, 47(4), pp. 588–605. Available at: https://doi.org/10.1080/02602938.2021.1933379.

Smyth, E. and Banks, J. (2012) ‘High stakes testing and student perspectives on teaching and learning in the Republic of Ireland’, *Educational Assessment, Evaluation and Accountability*, 24(4), pp. 283–306. Available at: https://doi.org/10.1007/s11092-012-9154-6.

Somekh, B. (1994) ‘Inhabiting Each Other’s Castles: Towards knowledge and mutual growth through collaboration’, *Educational Action Research*, 2(3), pp. 357–381. Available at: https://doi.org/10.1080/0965079940020305.

Somekh, B. (1995) ‘The Contribution of Action Research to Development in Social Endeavours: a position paper on action research methodology’, *British Educational Research Journal: Teacher Research: Methodological and Empowerment Issues in Practical Research for Improved Teaching and Learning*, 21(3), pp. 339–355. Available at: http://www.jstor.org/stable/1501651.

Somekh, B. and Zeichner, K. (2009) ‘Action research for educational reform: Remodelling action research theories and practices in local contexts’, *Educational Action Research*, 17(1), pp. 5–21. Available at: https://doi.org/10.1080/09650790802667402.

Speckesser, S. *et al.* (2018) *Embedding Formative Assessment: Evaluation report and executive summary*.

Stiggins, R.J. (2002) ‘Assessment crisis: The absence of assessment for learning’, *The Phi Delta Kappan*, 83(10), pp. 758–765. Available at: https://www.jstor.org/stable/20440249.

Stobart, G. (2008) *Testing times: the uses and abuses of assessment*. 1st edn, *Assessment in Education: Principles, Policy & Practice*. 1st edn. Oxon: Routledge.

Stokhof, H. *et al.* (2017) ‘Mind Map Our Way into Effective Student Questioning: a Principle-Based Scenario’, *Research in Science Education*, pp. 1–23. Available at: https://doi.org/10.1007/s11165-017-9625-3.

Stringer, E.T. (1999) ‘Action research’, *Action research* [Preprint]. 2nd ed. Thousand Oaks, Calif: Sage Publications.

Sullivan, B. (2006) *A Living Theory of a Practice of Social Justice: Realising the Right of Traveller Children to Educational Equality*. University of Limerick.

Sutton, P. (2012) ‘Conceptualizing feedback literacy: knowing, being, and acting’, *Innovations in Education and Teaching International*, 49(1), pp. 31–40. Available at: https://doi.org/10.1080/14703297.2012.647781.

Sweller, J. (2020) ‘Cognitive load theory and educational technology’, *Educational Technology Research and Development*, 68(1), pp. 1–16. Available at: https://doi.org/10.1007/s11423-019-09701-3.

Taras, M. (2002) ‘Using assessment for learning and learning from assessment’, *Assessment and Evaluation in Higher Education*, 27(6), pp. 501–510. Available at: https://doi.org/10.1080/0260293022000020273.

Taylor, P. *et al.* (2024) *Embedding Formative Assessment scale-up evaluation*.

Tomlinson, C.A. (2014) *The Differentiated Classroom : Responding to the Needs of All Learners*. Alexandria, USA: Association for Supervision & Curriculum Development. Available at: https://www.proquest.com/scholarly-journals/differentiated-classroom-responding-needs-all/docview/206698784/se-2.

Torrance, H. and Pryor, J. (2001) 'Developing formative assessment in the classroom: Using action research to explore and modify theory', *British Educational Research Journal*, 27(5), pp. 615–631. Available at: https://doi.org/10.1080/01411920120095780.

Trochim, W.M.K. and Donnelly, J.P. (2006) *The Research Methods Knowledge Base*, *WebRef*.

Tsai, Y.S., Gašević, D. and Whitelock-Wainwright, A., Muñoz-Merino, P. J., Moreno-Marcos, P. M., Fernández, A. R. & Tammets, K. (2018) *Sheila: Supporting Higher Education to Integrate Learning Analytics Research Report*, *SHEILA Project*. Available at: https://doi.org/10.4324/9780429029967-6.

UNESCO (2023) *Global education monitoring report, 2023: technology in education: a tool on whose terms?* Available at: https://doi.org/https://doi.org/10.54676/UZQV8501.

Vanstone, D.M. and Hicks, R.E. (2019) 'Transitioning to university: Coping styles as mediators between adaptive-maladaptive perfectionism and test anxiety', *Personality and Individual Differences*, 141(November 2018), pp. 68–75. Available at: https://doi.org/10.1016/j.paid.2018.12.026.

Velan, G.M. *et al.* (2002) 'Web-based self-assessments in pathology with Questionmark Perception', *Pathology*, 34(3), pp. 282–284. Available at: https://doi.org/10.1080/00313020220131372.

Venkatesh, V. and Davis, F.D. (2000) 'A theoretical extension of the technology acceptance model: Four longitudinal field studies', *Management Science*, 46(2), pp. 186–204. Available at: https://www.jstor.org/stable/2634758.

Voerman, L. *et al.* (2012) 'Types and frequencies of feedback interventions in classroom interaction in secondary education', *Teaching and Teacher Education*, 28(8), pp. 1107–1115. Available at: https://doi.org/10.1016/j.tate.2012.06.006.

Voogt, J. *et al.* (2013) 'Technological pedagogical content knowledge - A review of

the literature', *Journal of Computer Assisted Learning*, 29(2), pp. 109–121. Available at: https://doi.org/10.1111/j.1365-2729.2012.00487.x.

Vygotsky, L. (1978) 'Interaction between learning and development', *Mind in Society*. Cambridge MA: Harvard University Press, pp. 79–91.

Walck-Shannon, E.M. *et al.* (2019) 'Participation in voluntary re-quizzing is predictive of increased performance on cumulative assessments in introductory biology', *CBE Life Sciences Education*, 18(2), pp. 1–13. Available at: https://doi.org/10.1187/cbe.18-08-0163.

Walker, D.J., Topping, K. and Rodrigues, S. (2008) 'Student reflections on formative e-assessment: Expectations and perceptions', *Learning, Media and Technology*, 33(3), pp. 221–234. Available at: https://doi.org/10.1080/17439880802324178.

Warburton, B. (2009) 'Quick win or slow burn: Modelling UK HE CAA uptake', *Assessment and Evaluation in Higher Education*, 34(3), pp. 257–272. Available at: https://doi.org/10.1080/02602930802071080.

Watters, A. (2019) 'Fables of School Reform', *The Baffler*, 1(43). Available at: https://thebaffler.com/salvos/fables-of-school-reform-watters.

Weurlander, M. *et al.* (2012) 'Exploring formative assessment as a tool for learning: Students' experiences of different methods of formative assessment', *Assessment and Evaluation in Higher Education*, 37(6), pp. 747–760. Available at: https://doi.org/10.1080/02602938.2011.572153.

Whitehead, A.J. and McNiff, J. (2006) *Action Research: Living Theory*, *Assessment*. London: SAGE Publications Ltd. Available at: https://doi.org/10.1007/s13398-014-0173-7.2.

Whitehead, J. (2016) 'Embracing the "messiness" of action research in enhancing your educational influences in learning with the Network Educational Action Research Ireland (NEARI)', in *The effects of brief mindfulness intervention on acute pain experience: An examination of individual difference*. Dublin, pp. 1–20. Available at: https://doi.org/10.1017/CBO9781107415324.004.

Whitehead, J. *et al.* (2020) 'Self-Study in Elementary and Secondary Teaching: A Living Theory Approach', in J. Kitchen et al. (eds) *International Handbook of Self-Study of Teaching and Teacher Education Practices*. 2nd edn. Rotterdam: Springer.

Whitelock, D., Thorpe, M. and Galley, R. (2015) 'Student workload: a case study of

its significance, evaluation and management at the Open University', *Distance Education*, 36(2), pp. 161–176. Available at: https://doi.org/10.1080/01587919.2015.1055059.

Whitworth, D.E. and Wright, K. (2015) 'Online assessment of learning and engagement in university laboratory practicals', *British Journal of Educational Technology*, 46(6), pp. 1201–1213. Available at: https://doi.org/10.1111/bjet.12193.

Wiliam, D. (2011) 'What is assessment for learning?', *Studies in Educational Evaluation*, 37(1), pp. 3–14. Available at: https://doi.org/10.1016/j.stueduc.2011.03.001.

Wiliam, D. and Thompson, M. (2008) 'Integrating Assessment with Learning: What Will It Take to Make It Work?', in C.A. Dwyer (ed.) *The Future of Assessment*. 1st Ed. New York: Routledge.

Winstone, N. and Carless, D. (2020) *Designing Effective Feedback Processes in Higher Education: A Learning-Focused Approach*, *Designing Effective Feedback Processes in Higher Education: A Learning-Focused Approach*. London: Routledge. Available at: https://doi.org/10.4324/9781351115940.

Winstone, N. and Nash, R. (2016) *The Developing Engagement with Feedback Toolkit (DEFT)*, *Higher Education Academy*. Available at: https://www.heacademy.ac.uk/knowledge-hub/developing-engagement-feedback-toolkit-deft.

Winstone, N.E. *et al.* (2017) 'Supporting Learners' Agentic Engagement With Feedback: A Systematic Review and a Taxonomy of Recipience Processes', *Educational Psychologist*, 52(1), pp. 17–37. Available at: https://doi.org/10.1080/00461520.2016.1207538.

Winstone, N.E. and Boud, D. (2022) 'The need to disentangle assessment and feedback in higher education', *Studies in Higher Education*, 47(3), pp. 656–667. Available at: https://doi.org/10.1080/03075079.2020.1779687.

Wolsey, T.D. (2008) 'Efficacy of Instructor Feedback on Written Work in an Online Program', *International Journal on E-Learning*, 7(2), pp. 311–329. Available at: https://www.proquest.com/scholarly-journals/efficacy-instructor-feedback-on-written-work/docview/210332606/se-2.

Wood, L. and Zuber-Skerrit, O. (2013) 'PALAR as a methodology for community

engagement by faculties of education', *South African Journal of Education*, 33(4), pp. 1–15. Available at: https://doi.org/10.15700/201412171322.

Wu, Q. and Jessop, T. (2018) 'Formative assessment: missing in action in both research-intensive and teaching focused universities?', *Assessment and Evaluation in Higher Education*, 43(7), pp. 1019–1031. Available at: https://doi.org/10.1080/02602938.2018.1426097.

Wylie, E.C. and Lyon, C.J. (2016) *Using the Formative Assessment Rubrics, Reflection and Observation Tools to Support Professional Reflection on Practice (Revised)*.

Y1Feedback Report (2016) *Technology-Enabled Feedback in the First Year: A Synthesis of the Literature*.

Yorke, M. (2001) 'Formative assessment and its relevance to retention', *Higher Education Research and Development*, 20(2), pp. 115–126. Available at: https://doi.org/10.1080/758483462.

Yorke, M. (2003) 'Formative assessment in higher education: Moves towards theory and the enhancement of pedagogic practice', *Higher Education*, 45(4), pp. 477–501. Available at: https://doi.org/10.1023/A:1023967026413.

Zawacki-Richter, O. *et al.* (2019) 'Systematic review of research on artificial intelligence applications in higher education – where are the educators?', *International Journal of Educational Technology in Higher Education*, 16(1). Available at: https://doi.org/10.1186/s41239-019-0171-0.

Zeng, W. *et al.* (2018) 'Towards a learning-oriented assessment to improve students' learning—a critical review of literature', *Educational Assessment, Evaluation and Accountability*, 30(3), pp. 211–250. Available at: https://doi.org/10.1007/s11092-018-9281-9.

Zeni, J. (1998) 'A guide to ethical issues and action research', *Educational Action Research*, 6(1), pp. 9–19. Available at: https://doi.org/10.1080/09650799800200053.

Zhang, T. (2022) *National Developments in Learning and Teaching in Europe: A Report from the Leadership and Organisation for Teaching and Learning at European Universities (LOTUS) Project*, *European University Association*. Brussels.

Zimmerman, B.J. (2002) 'Becoming a Self-Regulated Learner: An Overview', *Theory into Practice*, 41(2). Available at:

http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Becoming+Learner+:+Self-Regulated+Overview#6 (Accessed: 7 March 2014).

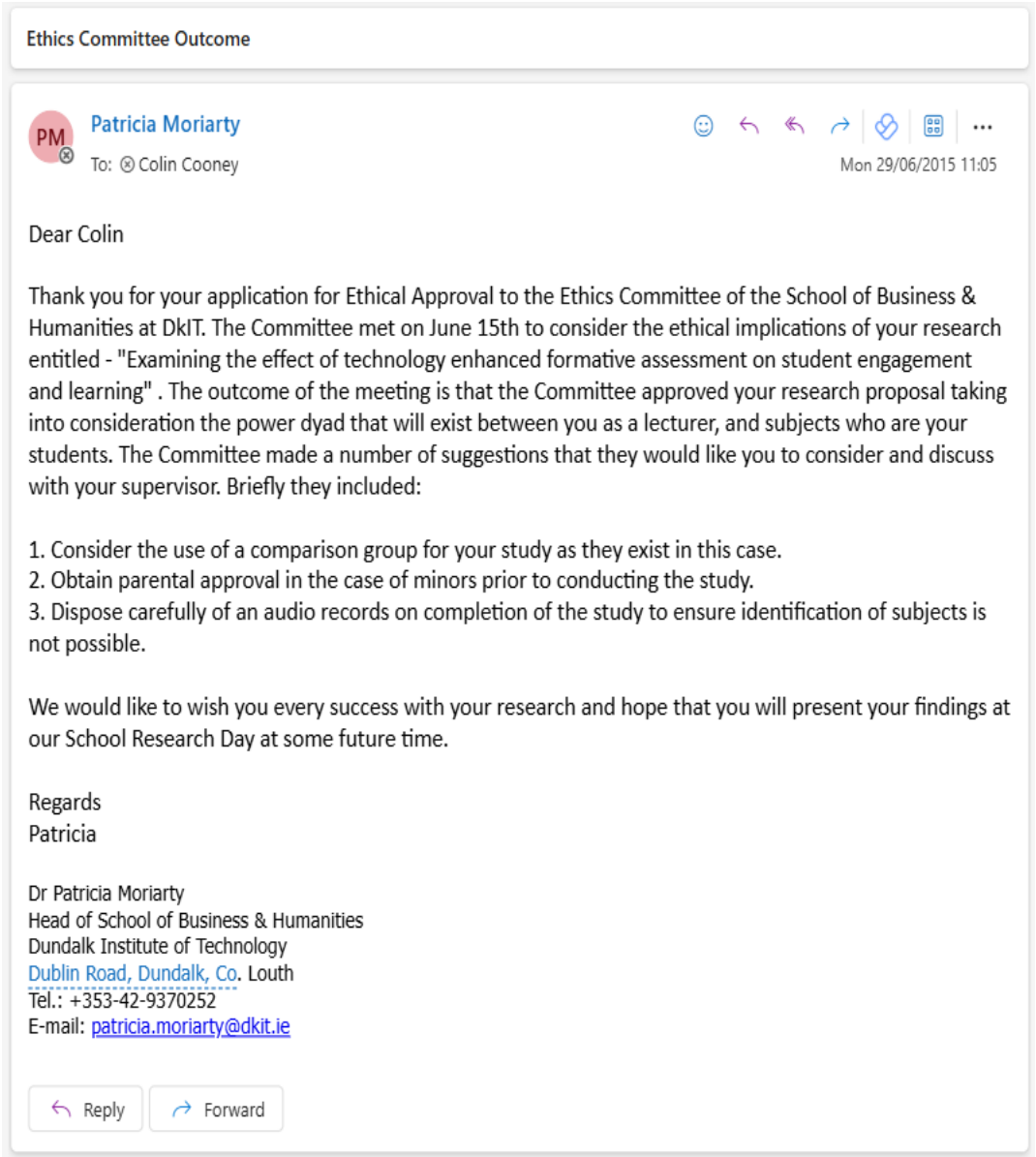
Zimmerman, B.J. (2008) 'Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects', *American Educational Research Journal*, 45(1), pp. 166–183. Available at: https://doi.org/10.3102/0002831207312909.

Zuber-Skerritt, O. (1996) *New directions in action research* . London ; Falmer Press.

Appendices

Appendix A: Ethics Documentation

A1: Ethical approval - My institution



Ethics Committee Outcome

PM Patricia Moriarty

To: Colin Cooney

Mon 29/06/2015 11:05

Dear Colin

Thank you for your application for Ethical Approval to the Ethics Committee of the School of Business & Humanities at DkIT. The Committee met on June 15th to consider the ethical implications of your research entitled - "Examining the effect of technology enhanced formative assessment on student engagement and learning" . The outcome of the meeting is that the Committee approved your research proposal taking into consideration the power dyad that will exist between you as a lecturer, and subjects who are your students. The Committee made a number of suggestions that they would like you to consider and discuss with your supervisor. Briefly they included:

1. Consider the use of a comparison group for your study as they exist in this case.
2. Obtain parental approval in the case of minors prior to conducting the study.
3. Dispose carefully of an audio records on completion of the study to ensure identification of subjects is not possible.

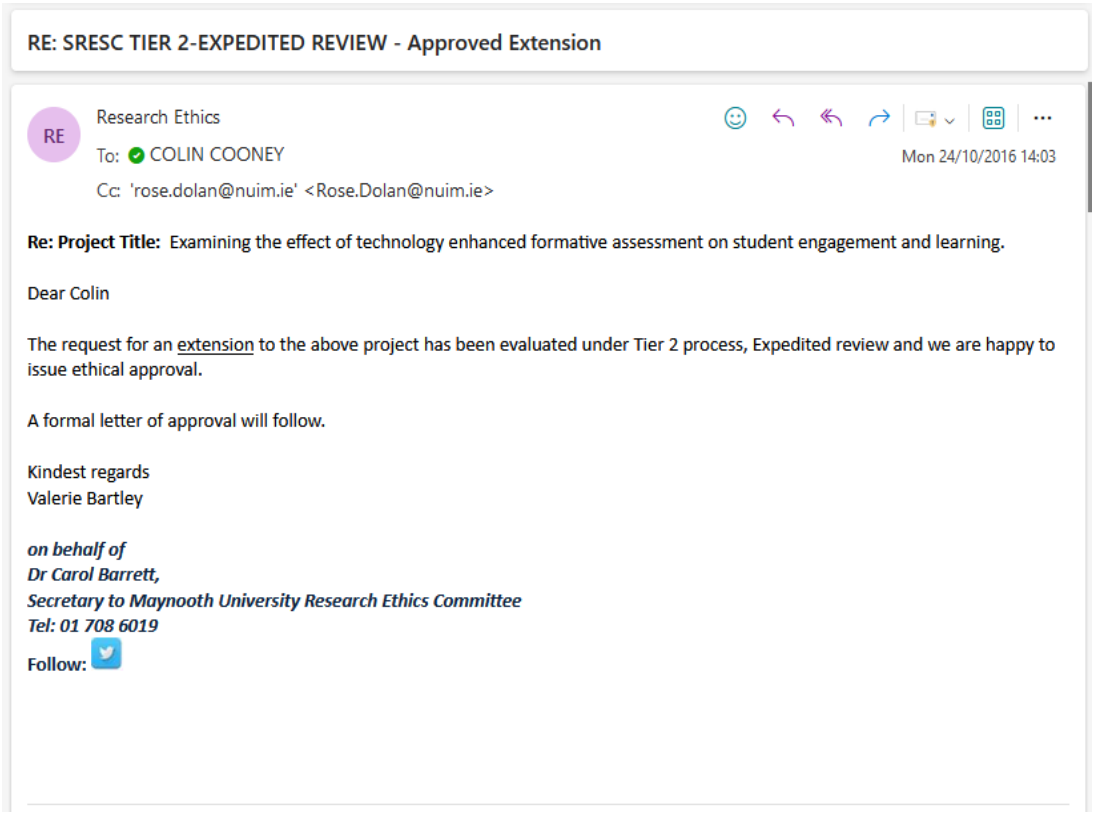
We would like to wish you every success with your research and hope that you will present your findings at our School Research Day at some future time.

Regards
Patricia

Dr Patricia Moriarty
Head of School of Business & Humanities
Dundalk Institute of Technology
Dublin Road, Dundalk, Co. Louth
Tel.: +353-42-9370252
E-mail: patricia.moriarty@dkit.ie

Reply Forward

A2: Ethical approval (Extension) – MU



RE: SRESC TIER 2-EXPEDITED REVIEW - Approved Extension

RE Research Ethics

To: COLIN COONEY

Mon 24/10/2016 14:03

Cc: 'rose.dolan@nuim.ie' <Rose.Dolan@nuim.ie>

Re: Project Title: Examining the effect of technology enhanced formative assessment on student engagement and learning.

Dear Colin

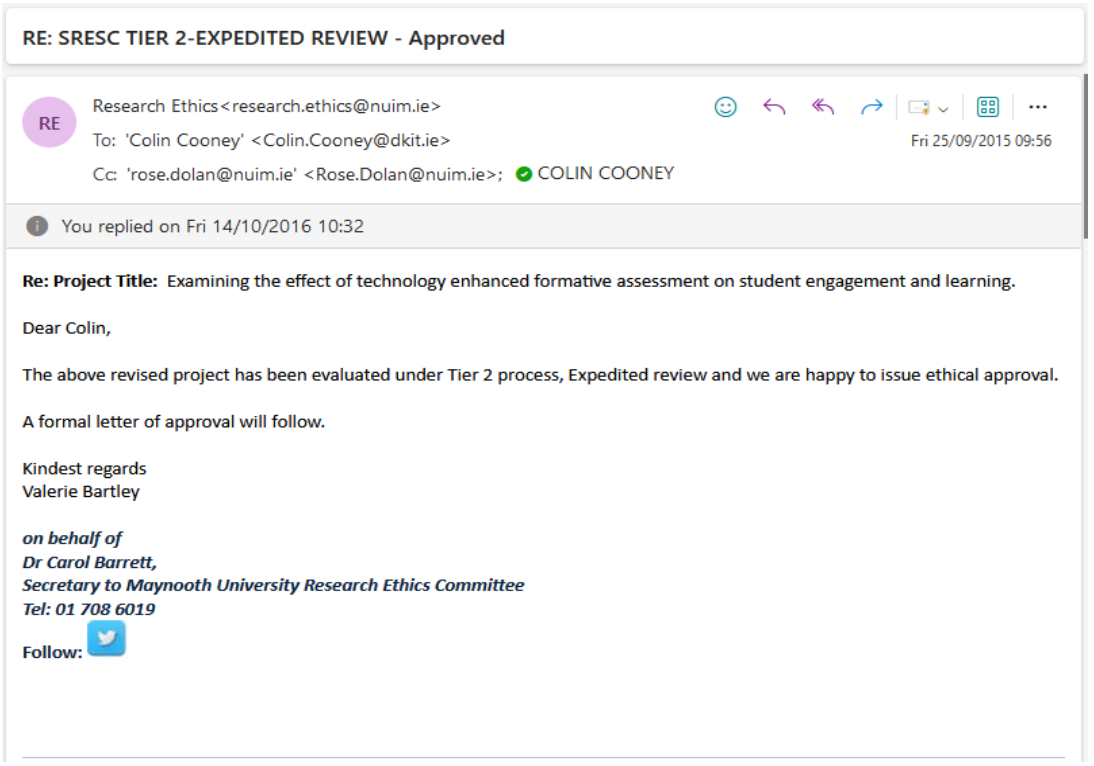
The request for an extension to the above project has been evaluated under Tier 2 process, Expedited review and we are happy to issue ethical approval.

A formal letter of approval will follow.

Kindest regards
Valerie Bartley

on behalf of
Dr Carol Barrett,
Secretary to Maynooth University Research Ethics Committee
Tel: 01 708 6019
Follow:

A3: Ethical approval – MU



RE: SRESC TIER 2-EXPEDITED REVIEW - Approved

RE Research Ethics<research.ethics@nuim.ie>

To: 'Colin Cooney' <Colin.Cooney@dkit.ie>

Fri 25/09/2015 09:56

Cc: 'rose.dolan@nuim.ie' <Rose.Dolan@nuim.ie>; COLIN COONEY

You replied on Fri 14/10/2016 10:32

Re: Project Title: Examining the effect of technology enhanced formative assessment on student engagement and learning.

Dear Colin,

The above revised project has been evaluated under Tier 2 process, Expedited review and we are happy to issue ethical approval.

A formal letter of approval will follow.

Kindest regards
Valerie Bartley

on behalf of
Dr Carol Barrett,
Secretary to Maynooth University Research Ethics Committee
Tel: 01 708 6019
Follow:

A4: Research participant consent forms

Student Participant Information Letter

Participant Information Leaflet

Study title: Examining the effect of technology enhanced formative assessment on student engagement and learning

Researcher Name: **Colin Cooney (DkIT)**

Telephone number of Researcher: **042 9370200 ext. 2856**

Research Supervisor Name: **Dr. Rose Dolan (MU)**

You are being invited to take part in a research study to be carried out in the School of Business Studies and Humanities, Dundalk Institute of Technology (DkIT). The aim of this study is to use technology to improve the teaching of Technology Information Management (or Management Information Systems). It is therefore really important that we hear from you, the students, as you are the people who actually experiencing the modules first hand.

This study will investigate the use of technology to improve engagement and learning in the area of Business and IT. It will involve a structured set of online quizzes administered throughout Semester 1 and Semester 2. These quizzes will not carry any marks, but will provide you with instant feedback on each answer. It will also provide me with data to inform my teaching. You will be asked your opinion on how effective the quizzes are for your learning in this module. All surveys are totally anonymous.

It is important to evaluate this study to see how well it is working and how it could be improved. This evaluation will consist of surveys and focus group discussions throughout both Semesters. You are invited to take part in these.

Before you decide whether or not you wish to take part, you should read the information provided below carefully and, if you wish, discuss it with your family or friends. Take time to ask questions – don't feel rushed and don't feel under pressure to make a quick decision. You don't have to take part in this study.

Also, if you do decide to take part you can change your mind later without having to give a reason.

Why is this study being done?

Engaging students in large group teaching is important. The study is taking place because we wish to have a better understanding of how online quizzes can do this and which teaching and learning approaches are most helpful to our students.

This study is not a test or an exam and we will not be asking you to perform any skills as part of it. Instead, we will be asking you to tell us about your learning experience so that we can better understand it from your perspective.

Why am I being asked to take part?

You are being asked to take part because you have just started the Technology Information Management module and you will be aiming to learn this management information systems theory over Semester 1 and Semester 2 of this academic year.

How will the study be carried out?

This study will take place over Semester 1 and Semester 2 of this academic year. You will be asked to complete three surveys in each Semester. Each survey will ask your opinion about the effectiveness of the quizzes in terms of your engagement and learning in this module.

The surveys will be followed by a discussion session, called a focus group, at the end of each Semester. Everyone can complete the surveys but only four to eight volunteers will be needed for the discussion. This session will discuss the results of the surveys in more detail.

What will happen to me if I agree to take part?

- Students aged 18 and over will be invited to participate in the surveys and focus group discussions.

- The surveys will be completed online and will take an average of 15-20 minutes to complete. The responses will be collected, stored and published anonymously – your name will never be attached to your data and not even the researchers involved will know what your individual input to the surveys was.

- After the end of Semester 1, an anonymous focus group will take place, conducted by a lecturer who does not teach you. At the end of Semester 2, Colin Cooney and another lecturer will conduct the second focus group. The other lecturer is there as an independent observer and to help keep the discussion on track. The focus group interviews will be audio recorded and last approximately 40-45 minutes.

- For the two focus group discussions, the data collected will be in the form of an audio recording of the focus group discussion which will be transcribed for analysis. The identities of those who participate in the discussions will not be recorded, stored or published. The completed transcript will be shown to the participants so they can check that it is accurate. The audio recording file will then be deleted. Only the written transcript will be kept.

What are the benefits?

You will not receive any payment or other inducements or rewards to take part.

You will have the chance to contribute to a piece of original research that is designed to improve education in the School of Business Studies and Humanities, both for yourself and for other students who enter the course after you.

What are the risks?

There are no risks to you if you decide to take part. Your participation will not affect your education or course grades. You will have to contribute some of your time if you decide to participate: approximately 20 minutes for a survey and up to an hour if you participate in an end of term discussion.

What if something goes wrong when I'm taking part in this study?

If you wish to stop your participation in the study for any reason, you can withdraw at any stage. You can contact Colin Cooney or you can let another Business and IT lecturer, Seamus Rispin (seamus.rispin@dkit.ie, Office S220), know that you no longer wish to take part. Seamus will ensure that your data is removed and can direct you to further support services if necessary, e.g. the DkIT Centre for Teaching and Learning (CELT) [pauline.mcglade@dkit.ie] or any other relevant service.

Is the study confidential?

Yes. The surveys will be collected online and your name and computer IP address will not be recorded.

The focus group discussion recordings will be transcribed (written out) and then the recordings will be destroyed. All potentially identifying information will be removed from the transcripts and reporting of this data will be done anonymously.

All the data will be stored on a secure password protected server in Dundalk IT and only the researchers will have access to it. The data will be used to inform and improve teaching and for research purposes. If results of this study are published or presented, all data is anonymised, so no individual names or other personally identifiable information will be used. A copy of the findings will be made available to you on request.

Where can I get further information?

If you need any further information now or at any time in the future, please contact:
Colin Cooney (colin.cooney@dkit.ie)

Alternatively you can contact:

Seamus Rispin (seamus.rispin@dkit.ie) - Lecturer, DkIT

Shane Hill (shane.hill@dkit.ie) - Head of Department, DkIT

Dr. Colette Henry (colette.henry@dkit.ie) - Head of Department, DkIT

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the Maynooth University Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.

A5: Participant information sheets

Participant Consent Form - Surveys

Researcher: Colin Cooney

Study title: Examining the effect of technology enhanced formative assessment on student engagement and learning

1) I have been provided with an invitation to participate by email and also with a written copy of the **study information leaflet** outlining the purpose of the study that I have read and understood.
2) The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.
3) I give my informed consent to participate in the surveys. I understand that agreeing to take part means that my responses will be recorded and stored anonymously.
4) I understand that my participation is voluntary. I have also been made aware that I can withdraw from the study without reason, even if it has not finished. My refusing to participate will not involve a penalty or disadvantage me in any way. If I wish to withdraw I understand that I should inform Colin Cooney or Seamus Rispin (another Business & IT lecturer).
5) For the purpose and duration of the study all data will be stored securely, anonymously and confidentially. No one will have access to the transcripts except the researchers. My responses in the interview are anonymous and will be identified by an alias in the written report.
6) I consent to the publication of the study results so long as the information is kept anonymous, so that no identification can be made.
7) I have been informed that while there are no anticipated risks some discomfort may occur if unexpected/unintended issues emerge during focus group interviews. I have been informed that should this occur I can decide whether I want to continue with the interview.

Storage and future use of information:

I give my permission for information collected from me to be stored or electronically processed for the purpose of research and to be used in related studies or other studies in the future but only if the research is approved by a Research Ethics Committee.

To be completed by the participant:

Instead of asking participants to sign this form, this information will be included at the start of the online survey. If participants consent, they will tick a check box to show they agree to the conditions.

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the Maynooth University Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.

A6: Focus Group Consent Form (ARC1)

Participant Consent Form – Focus Groups

Researcher: Colin Cooney

Focus Group Leaders / Interviewers: Kevin Howard, Seamus Rispin

Study title: Examining the effect of technology enhanced formative assessment on student engagement and learning

1) I (the student) have been provided with an invitation to participate by email and also with a written copy outlining the purpose of the study that I have read and understood.
2) I give my informed consent to participate in the focus group interview and understand that agreeing to take part means that I am willing to allow the researcher to audio-record the focus group discussion. This is to make sure that the information accurately reflects what was said by me and the other participants.
3) I understand that my participation is voluntary. I have also been made aware that I can withdraw from the focus group even if it has not finished without reason. My refusing to participate will not involve a penalty or disadvantage me in any way.
4) For the purpose and duration of the study all data will be stored securely, anonymously and confidentially. No one will have access to the transcripts except the researchers. My responses in the interview are anonymous and will be identified by an alias in the written report.
5) I consent to the publication of the study results so long as the information is kept anonymous, so that no identification can be made.
6) I have been informed that there are no anticipated risks. However some discomfort may occur if unexpected/unintended issues emerge during the discussion. I have been informed should this occur I can decide whether I want to continue with the discussion or not.

Storage and future use of information:

I give my permission for information collected about me to be stored or electronically processed for the purpose of research and to be used in related studies or other studies in the future but only if the research is approved by a Research Ethics Committee.

Signature of Participant: _____

Date:_____

Name of Participant (Please Print):

To be completed by the Researcher:

I, the undersigned, have taken the time to fully explain to the above participant the nature and purpose of this study in a way that they could understand. I have explained the risks involved as well as the possible benefits. I have invited them to ask questions on any aspect of the study that concerned them.

Signature of Researcher / Moderator: _____ Date:

Name of Researcher / Moderator (Please Print): _____

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the Maynooth University Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.

Focus Group Introduction

Opening (5-10 Minutes):

“Hello. My name is ……...

Thank you for agreeing to be part of the focus group. We really appreciate your willingness to participate. Today I would like to have a conversation with you about the use of technology in education and more specifically, the use of online quizzes. What I am trying to accomplish is to assess your perceptions of the pros and cons of these quizzes. Also, I want to explore the extent to which you feel this technology affected your learning for this module.

Are there any questions?

Respond to participant questions.

Let’s go over some rules.

Focus Group Ground Rules

Mobile phones off:

- Ask people to turn off their phones to avoid interruptions and so they can focus on the topic.

One Person Talking at a Time:

- Inform the group that in order to keep notes & track of what people are saying, it is important that only one person at a time speaks.
- There are no right or wrong answers to the focus group questions.
- We want to hear many different viewpoints and would like to hear from everyone.
- Ask the participants to signal you if they have something to say.
- Please do not interrupt someone when they are talking.

Confidentiality:

- Inform the participants that everything they say will be kept completely confidential and that what is said in the room should stay in the room.
- The audio recording from this focus group will not identify names and will be sent directly to an independent, professional transcriber. This transcriber has been vetted and is bound by a confidentiality agreement. The recording will be treated with the highest level of professionalism and care.
- I (Colin Cooney) will review the completed transcripts for accuracy before any part of them will be used for my research.

Consent:

Before we begin please take a few moments to read over your consent form. Please feel free to ask any questions you might have before you sign it.

To be read out to students:

If during your participation in this study you feel the information and guidelines that you were given have been neglected or disregarded in any way, or if you are unhappy about the process, please contact the Secretary of the Maynooth University Ethics Committee at research.ethics@nuim.ie or +353 (0)1 708 6019. Please be assured that your concerns will be dealt with in a sensitive manner.

Focus Group Questions:

***Note**: These are sample questions for this semi-structured focus group. The questions on the day are likely to be similar but they will be guided by the results of the initial survey.*

- How many quizzes have you completed to date?
- Where did you complete the quizzes?
  - PC in lab, PC at home, Laptop, Tablet, Smartphone
- Quiz characteristics
  - Length / Number of questions: Too short, Just right, Too long?
  - Standard: Too easy / just right / too difficult?
  - Engaging: Not engaging / quite engaging / very engaging?
- Did you notice any differences in the two quiz platforms that were used?
- How helpful has the instant feedback & self-assessment been for you?
- What improvements would you make to the quizzes? / What features were good?
- Thinking about your previous experiences of having taken exams, do you think your preparation for this module's exam was enhanced by the use of the online quizzes?
  - Did you find the quiz(zes) helpful to your understanding of the topic?
  - Did the quizzes help you engage in the module?
  - Did the quizzes help you understand the course content?
- Would you have preferred if your marks in each quiz contributed to your CA grade?
- How do you think other students could be encouraged to engage with the quizzes?
- Thinking in relation to your programme as a whole, do you think quizzes are a useful way of encouraging learning?
  - Are there any modules / topics where quizzes would have no value?

Thanks and close

Some helpful probes that could be used include:

- Can you talk about that more?
- Help me understand what you mean.
- Can you give an example?
- Is there anything you would like to add?

Appendix B: Higher Education Institutions

B1: Overview of Participating Higher Education Institutions (General Context)

- HEI-A – Dundalk Institute of Technology (DkIT)
- HEI-B – Maynooth University

Appendix C: Summary of Action Research Cycles

Action Research Cycles - Summary

Cycle	What I did - Quiz data	Interventions/Changes (Quiz) What was informed? What was learning?	Interventions / Changes (Participation)	Participation / Observation
ARC1	Quiz 2 [Week7]- 41 q's (85a) Quiz 4 [Week7]-- 34 q's (60a) Quiz 5 [Week10]-- 18 q's (16a) Quiz 7 [Week13]-- 22 q's (25a) Total - 115 students (187a)	Quiz 4 Shorter Quiz 5,7 based on mid sem survey - Additional question types - Open-ended questions - More exam-focused - Better feedback Attended 2 workshops (Feedback [Week8] & Motivation and Emotion [Week9])	Cohorts (Programmes A, B, C, D) Emails & reminders Chapter summaries added	Moodle Logs - Quiz data - Engagement data - Attendance data Surveys - Start-of-semester survey [Week4] (94r) - Mid-semester survey [Week10] (56r) - End of Semester Survey [ARC2-Week3][64r] - End of Semester Focus Group [ARC2-Week4] Exam Results
ARC2	Quiz 8 [Week6]-- 25 q's (62a) Quiz 10 [Week10]-- 16 q's (57a) Quiz 6 [Week15](L) - 15 q's* Quiz 12 [Week14](L) - 11 q's* Quiz 13 [Week15]- 17 q's (22a) Total - 115 students * L=Learnosity Platform	Learnosity platform Additional question types Progress bar on Moodle activities Improved feedback Expanding/improving answers for open q's Sample answers for short questions How likely to take this exam question - (Metacognition)	Cohorts (Programmes A, B, C) Removed chapter summaries In-class demos	Moodle Logs - Quiz data - Engagement data - Attendance data Survey - End of Semester2 Survey [Week23] (29r) Focus Group - End of Semester2 Focus Group [Week27] Exam Results
ARC3	Quiz 1 [Week5]- 17 q's (129a) Quiz 2 [Week6]- 20 q's (67a) Quiz 4 [Week9]- 17 q's (52a) Quiz 5 [Week9]- 16 q's (31a) Quiz 7 [Week14]-- 14 q's (26a) Total - 101 students (305a)	Added Quiz 1 Analysis of Cycle 1 quiz answers/results Informed which questions to delete/modify	2 Cohorts. (Programmes A, B, C) Removed chapter summaries Dedicated lab time	Moodle Logs - Quiz data - Engagement data - Attendance data Survey - Mid-semester survey [Week11] (52r) - End of Semester Survey [Week23] (40r) Exam Results

Appendix D: Surveys

D1: Start-of-Semester Survey (ARC1)

Colin Cooney's Start of Semester Survey (AR1)

The information below is to inform you that this survey is voluntary, all data collected is totally anonymous and will be stored securely.

* 1. *Participant Consent Information*

1) I have been provided with an invitation to participate by email and also with a written copy of the study information leaflet outlining the purpose of the study that I have read and understood.

2) The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.

3) I give my informed consent to participate in the surveys during this academic year. I understand that agreeing to take part means that my responses will be recorded and stored anonymously.

4) I understand that my participation is voluntary. I have also been made aware that I can withdraw from the study without reason at any time. My refusing to participate will not involve a penalty or disadvantage me in any way. If I wish to withdraw I understand that I should inform Colin Cooney, Seamus Rispin (another Business & IT lecturer) or my Head of Department.

5) For the purpose and duration of the study, all data will be stored securely, anonymously and confidentially. Only the researchers will have access to the transcripts. If I take part in an interview, my responses in the interview are anonymous and will be identified by an alias in the written report.

6) I consent to the publication of the study results so long as the information is kept anonymous so that no identification can be made.

Storage and future use of information:
I give my permission for information collected from me to be stored or electronically processed for the purpose of research and to be used in related studies or other studies in the future but only if the research is approved by the Research Ethics Committee.

If you consent to the above, please tick the checkbox below to show you have agreed to the conditions.

◯ I agree

Next

This survey is designed to gather information from you at the beginning of the Semester.

2. What is your anonymous self-generated code?

3. What programme are you studying?

4. Which of the following digital devices do you have access to? (Tick all that apply)

- [ ] Desktop PC
- [ ] Laptop
- [ ] Smartphone
- [ ] Tablet
- [ ] IPod Touch
- [ ] More than 5
- [ ] Other (please specify)

5. In a typical week, how many times do you access Moodle? (For all modules)

- ◯ None
- ◯ 1-3
- ◯ 4-6
- ◯ 7-10
- ◯ More than 10

6. In how many other modules have you previously used online Moodle quizzes?

- ◯ None
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ More than 6

7. If you have previously completed a Moodle quiz as part of another module, please indicate your level of agreement with each of the following statements:

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
It helped me engage with the module.	○	○	○	○	○
It helped me achieve the learning objectives	○	○	○	○	○

8. If there was a practice quiz available in this module for revision purposes on certain topics, do you think you would you use them for your learning (even if no marks were awarded)?

- ○ Yes
- ○ No
- ○ Maybe

9. How often do you typically access Moodle from the following locations?

	Never	Sometimes	Often
In-class	○	○	○
Library	○	○	○
Canteen / Common Room	○	○	○
Computer lab	○	○	○
Home	○	○	○
Other	○	○	○

Other (please specify)

10. When accessing Moodle, which of the following devices do you use?

	Never	Sometimes	Often
Laptop	○	○	○
PC at home	○	○	○
PC in Lab	○	○	○
PC in Library	○	○	○
Smartphone	○	○	○
Tablet	○	○	○

Other (please specify)

11. Thinking of your experience of this module to date, please indicate your level of agreement with each of the following statements:

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
The module is well structured	○	○	○	○	○
The module content is relevant to my programme	○	○	○	○	○
The module content is difficult	○	○	○	○	○
The module is intellectually stimulating	○	○	○	○	○
I have a clear understanding of the aims and goals of each topic	○	○	○	○	○
The learning materials on Moodle assist me in the module	○	○	○	○	○

Prev Done

D2: Mid-Semester Survey (ARC1)

Mid Semester Questionnaire

How many quizzes have you attempted for this module? (Tick the box)

	None
	One
	Two

If you ***have not*** attempted a quiz yet, do you plan to attempt one before the January exam?

	Yes
	No
	Maybe

The remaining questions are only for students who have attempted a quiz, so if you have not, you can skip to the Page 4 now.

If you have attempted a quiz, approximately, how many times did you attempt that quiz?

	1 - 2 times
	3 – 5 times
	6 – 8 times
	9+ times

Quiz Characteristics

If you have attempted a quiz to date, please fill out the following questionnaire to assess your opinion of the quiz. The questionnaire consists of pairs of contrasting attributes that may apply to the quiz. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

Boring	○ ⊗ ○ ○ ○ ○ ○	Engaging

This response would mean that you rate the quiz as being more boring than engaging.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Mental demand: How mentally challenging was the quiz?

easy	○ ○ ○ ○ ○ ○ ○	demanding

Level of Performance: How successful were you in completing the quiz?

low	○ ○ ○ ○ ○ ○ ○	high

Please answer the remaining questions by ticking the box that best describes your opinion on the quiz(zes).

boring	○	○	○	○	○	○	○	engaging
motivating	○	○	○	○	○	○	○	demotivating
clear	○	○	○	○	○	○	○	confusing
too short	○	○	○	○	○	○	○	too long
helpful	○	○	○	○	○	○	○	useless
conservative	○	○	○	○	○	○	○	innovative

Any comments?

Thank you for your valued input.

D3: End-of-Semester Survey (ARC1)

End of Semester 1 Questionnaire

Write down your self-generated, anonymous code, if you remember it.

Did you complete the Mid-Semester survey in Semester 1? (in-class on 18/11/15)

	Yes
	No

Did you attempt any online quizzes for this module in Semester 1?

	Yes
	No

If yes, go straight to Page 2.

If you ***did not*** attempt a quiz in Semester 1, do you plan to attempt any quizzes in Semester 2?

	Yes
	No

If you did not attempt a quiz in Semester 1, can you outline the main reason(s) why you did not.

The remaining questions are only for students who have attempted a quiz, so if you have not, you can skip to the back page now.

Which quizzes did you attempt for this module? (Tick the relevant boxes)

	Chapter 2: Global E-Business & Collaboration
	Chapter 4: Ethical and Social Issues in Information Systems
	Chapter 5: IT Infrastructure & Emerging Technologies
	Chapter 7: Telecommunications, the Internet and Wireless Technologies

Do you plan to attempt any quizzes in Semester 2?

	Yes
	No

On average, how many times did you attempt each quiz? (Tick the box)

	1 – 2 times
	3 – 5 times
	6 – 8 times
	9+ times

To what extent do you agree or disagree with the following statements:

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Completing the quiz(zes) helped me prepare for the final exam.					
Completing the quiz(zes) helped me engage better in the module material.					
Completing the quiz(zes) increased my exam grade.					

Quiz Characteristics

The questions below consist of pairs of contrasting attributes that may apply to the quiz.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please answer the following questions by ticking the box that best describes your opinion of the quiz(zes).

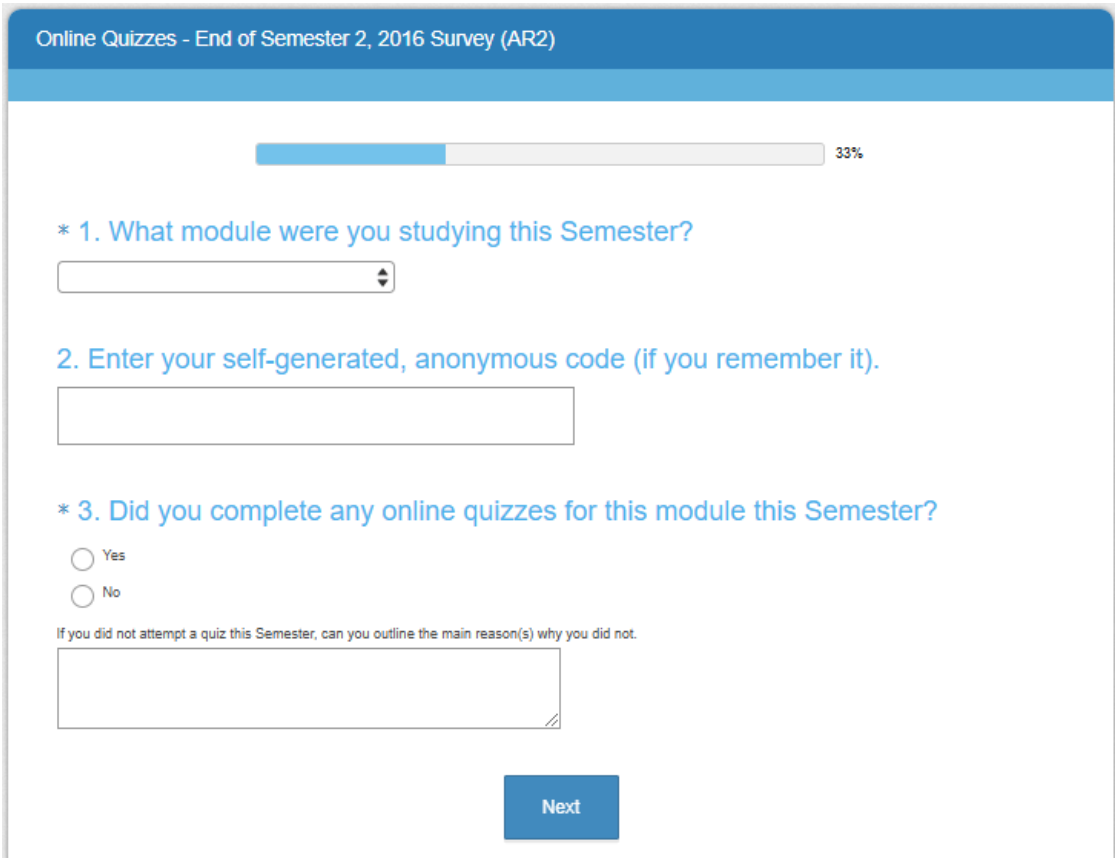
boring	○	○	○	○	○	○	○	engaging
motivating	○	○	○	○	○	○	○	demotivating
clear	○	○	○	○	○	○	○	confusing
too short	○	○	○	○	○	○	○	too long
helpful	○	○	○	○	○	○	○	useless

What features of the quizzes did you find most helpful?

If you would like to elaborate on any of the topics covered in this survey, or if you have any comments on the use of the quizzes as part of this module or ways to improve them, please use the space below.

Thank you for your valued input.

D4: End-of-Semester Survey (ARC2)



Online Quizzes - End of Semester 2, 2016 Survey (AR2)

67%

There were two different types of quiz platforms used this Semester. One was a Moodle quiz and the other used a different platform called Learnosity. All quizzes were accessed via the Moodle page for this module. The next two questions (Q4, Q5) ask you for feedback on each of these platforms.

4. For the Moodle Quizzes - Rank the quiz questions and platform under the following headings. (e.g. Chapter 8, Chapter 10)

	1	2	3	4	5	6	7
Engagement level [1-Boring to 7-Engaging]	○	○	○	○	○	○	○
Engagment level [1-Motivating to 7-Demotivating]	○	○	○	○	○	○	○
Clarity [1-Clear to 7-Confusing]	○	○	○	○	○	○	○
Length [1-Too Short to 7-Too Long]	○	○	○	○	○	○	○
Worthwhile [1-Helpful to 7-Useless]	○	○	○	○	○	○	○
[1-Conservative to 7-Innovative]	○	○	○	○	○	○	○

Any comments on the Moodle quizzes?

5. For the Learnosity Quizzes - Rank the quiz questions and platform under the following headings. (e.g. Chapter 6, Chapter 12).

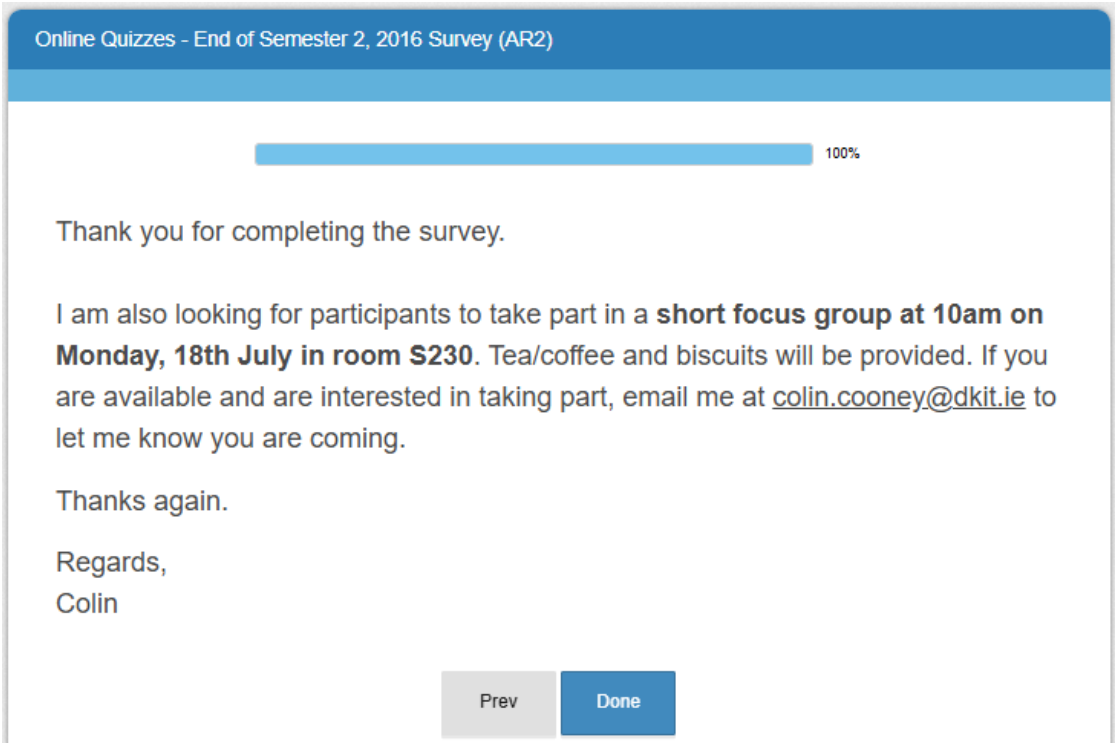
	1	2	3	4	5	6	7
Engagement level [1-Boring to 7-Engaging]	○	○	○	○	○	○	○
Engagement level [1-Motivating to 7-Demotivating]	○	○	○	○	○	○	○
Clarity [1-Clear to 7-Confusing]	○	○	○	○	○	○	○
Length [1-Too Short to 7-Too Long]	○	○	○	○	○	○	○
Worthwhile [1-Helpful to 7-Useless]	○	○	○	○	○	○	○
[1-Conservative to 7-Innovative]	○	○	○	○	○	○	○

Any comments on the Learnosity quizzes?

6. To what extent do you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Completing the quiz(zes) helped me prepare for the final exam.	○	○	○	○	○
Completing the quiz(zes) helped me engage better in the module material.	○	○	○	○	○
Completing the quiz(zes) increased my exam grade.	○	○	○	○	○

7. What features of the quizzes did you find most helpful? Also, if you have any comments on the use of the quizzes as part of this module or ways to improve them, please comment in the space below.


Online Quizzes - End of Semester 2, 2016 Survey (AR2)
100%
Thank you for completing the survey.
I am also looking for participants to take part in a short focus group at 10am on Monday, 18th July in room S230. Tea/coffee and biscuits will be provided. If you are available and are interested in taking part, email me at colin.cooney@dkit.ie to let me know you are coming.
Thanks again.
Regards,
Colin
Prev
Done

D5: Mid-Semester Survey (ARC3)

Mid Semester Questionnaire

What is your anonymous ID?

How many quizzes have you attempted for this module? (Tick the box)

	None
	One
	Two
	Three
	Four

If you ***have not*** attempted a quiz yet, do you plan to attempt one before the January exam? Also, can you outline the main reason(s) why you have not attempted a quiz.

	Yes
	No
	Maybe

Main reasons for not attempting quiz

The remaining questions are only for students who have attempted a quiz, so if you have not, you can skip to the Page 4 now.

If you have attempted a quiz, approximately, how many times did you attempt that quiz?

	1 - 2 times
	3 – 5 times
	6 – 8 times
	9+ times

Quiz Characteristics

If you have attempted a quiz to date, please fill out the following questionnaire to assess your opinion of the quiz. The questionnaire consists of pairs of contrasting attributes that may apply to the quiz. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression.

Example:

Boring	○ ⊗ ○ ○ ○ ○ ○	Engaging

This response would mean that you rate the quiz as being more boring than engaging.

Please decide spontaneously. Don't think too long about your decision to make sure that you convey your original impression.

Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Mental demand: How mentally challenging was the quiz?

easy	○	○	○	○	○	○	○	demanding

Level of Performance: How successful were you in completing the quiz?

low	○	○	○	○	○	○	○	high

Please answer the remaining questions by ticking the box that best describes your opinion on the quiz(zes).

boring	○	○	○	○	○	○	○	engaging
motivating	○	○	○	○	○	○	○	demotivating
clear	○	○	○	○	○	○	○	confusing
too short	○	○	○	○	○	○	○	too long
helpful	○	○	○	○	○	○	○	useless
conservative	○	○	○	○	○	○	○	innovative

Any comments on your use of the quiz(zes) so far?

D6: End-of-Semester Survey (ARC3)

End of Semester 1 Questionnaire – TIM1

Write down your self-generated, anonymous code, if you remember it.

Did you attempt any online quizzes for this module in Semester 1?

	Yes
	No

If yes, go straight to Page 2.

If you ***did not*** attempt a quiz in Semester 1, do you plan to attempt any quizzes in Semester 2?

	Yes
	No

If you did not attempt a quiz in Semester 1, can you outline the main reason(s) why you did not.

The remaining questions are only for students who have attempted a quiz, so if you have not, you can skip to the back page now.

Which quizzes did you attempt for this module? (Tick the relevant boxes)

	Chapter 1: Information Systems in Global Business Today
	Chapter 2: Global E-Business & Collaboration
	Chapter 4: Ethical and Social Issues in Information Systems
	Chapter 5: IT Infrastructure & Emerging Technologies
	Chapter 7: Telecommunications, the Internet and Wireless Technologies

On average, how many times did you attempt each quiz? (Tick the box)

	1 – 2 times
	3 – 5 times
	6 – 8 times
	9+ times

Do you plan to attempt any quizzes in Semester 2?

	Yes
	No

To what extent do you agree or disagree with the following statements:

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Completing the quiz(zes) helped me prepare for the final exam.					
Completing the quiz(zes) helped me engage better in the module material.					
Completing the quiz(zes) increased my exam grade.					

Quiz Characteristics

The questions below consist of pairs of contrasting attributes that may apply to the quiz.

Please decide spontaneously. Don’t think too long about your decision to make sure that you convey your original impression.

It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Please answer the following questions by ticking the box that best describes your opinion of the quiz(zes).

boring	○	○	○	○	○	○	○	engaging
motivating	○	○	○	○	○	○	○	demotivating
clear	○	○	○	○	○	○	○	confusing
too short	○	○	○	○	○	○	○	too long
helpful	○	○	○	○	○	○	○	useless

What features of the quizzes did you find most helpful?

If you would like to elaborate on any of the topics covered in this survey, or if you have any comments on the use of the quizzes as part of this module or ways to improve them, please use the space below.

Appendix E: Quantitative and Qualitative Analysis

E1: ARC1 VLE Analysis

Event name	COUNTA of Times
Course module instance list viewed	91
Course module viewed	2574
Course viewed	1877
Discussion viewed	9
Grade overview report viewed	1
Grade user report viewed	15
Quiz attempt reviewed	202
Quiz attempt started	179
Quiz attempt submitted	142
Quiz attempt summary viewed	160
Quiz attempt viewed	787
User graded	218
User profile viewed	1
User unenrolment updated	8
Grand Total	**6264**

Figure 46 Pivot Table Analysis of Moodle VLE Data (ARC1)

COUNTUNIQUE (Chart 1 Event Type				
Week Commenc	Moodle Usage	Quiz	Grand Total	**Week**
07/09/2015	10		10	Week 0
14/09/2015	39		39	Week 1 (Semester Begins)
21/09/2015	38		38	Week 2
28/09/2015	47		47	Week 3
05/10/2015	42		42	Week 4
12/10/2015	32		32	Week 5
19/10/2015	19		19	Week 6
26/10/2015	12	4	12	Week 7 (Mid-Term)
02/11/2015	38	14	38	Week 8
09/11/2015	42	12	42	Week 9
16/11/2015	29	4	29	Week 10
23/11/2015	18	1	18	Week 11
30/11/2015	20	1	20	Week 12
07/12/2015	30	2	30	Week 13
14/12/2015	19	3	19	Week 14 (Semester Ends)
21/12/2015	10	1	10	Week 15
28/12/2015	4		4	Week 16
04/01/2016	17		17	Week 17
11/01/2016	112	38	112	Week 18
18/01/2016	36	10	36	Week 19 (Exam)
Grand Total	**119**	**60**	**119**	

Figure 47 Pivot Table Analysis of Moodle VLE Data (ARC1)

E2: Focus Group Analysis (ARC2)

Speaker/Th	FGSpeaker1	FGSpeaker2	FGSpeaker3	FGSpeaker4	FGSpeaker5	FGSpeaker6	FGSpeaker7	FGSpeaker8
Utilisation of Quizzes	"all of them"	"All the Moodle quizzes."	"The quizzes I did were shorter and had shorter questions."	"I only did the quizzes pertaining to the exam I was going to do."	"I didn't do any of them." "I looked at one of the quizzes in semester 2. I answered a few questions and thought I had better things to do, so I closed it and walked away."	"I think I did one only."	"I did one or two but they were helpful."	"I did all five of them this semester and all four of them last semester."
Selective Study Approach	"I did the quizzes before I did any study. Then how I did in the quizzes helped me decide what topics to study further." "It focused my attention on topics I needed to study more, or didn't need to study more." "There would be a subtle difference between the possible answers and you'd have to really think about why you got it wrong. They followed on from each other. Collectively they formed the bones of an essay question, i.e. multiple questions on one topic. You could expand on this later."	"At Christmas I did all the ones that were available."	"I started the quizzes before I did any study." "I was working out what topics I would do in the exam. So knowing those topics, I did the quizzes before any study. As a result, they were difficult, but if I got a reasonable mark I would continue with that topic. If I did terrible, I might reconsider my choice of topic." "The open ended answers got me thinking." "I didn't do any of this during the term time. The exam was on a Thursday and I literally started doing the quizzes on the previous saturday."	"So of the three topics, I did quizzes pertaining to those." "So I didn't do any quizzes, in advance of the Christmas exams as far as I can remember. But for the summer exam, I decided what topics I was going to study. So of the three topics, I did quizzes pertaining to those. I never looked at the others because I was thinking that's going to do those topics. I had to manage my time."	"The yes/no answers were great. And good for study."	"It was on a topic I had decided I was going to do for the exam." "I left it too late to start, so my work was in the run up to the exams."	[No direct quote provided]	"I did the quizzes on all of the topics. I did it to help to prepare for the exam questions." "You're reading through the sentence of the question. Then you figure out what is being asked. The answer to that question is the thing is what they want you to fill in. You engaged with this. Then the feedback was really great when I did it." "And it gives you more insight and understanding of what is being taught in class, which I think is great." "In class, sometimes, with say the noise, but it's not a big thing, but there are things you can't grasp in class. But when you are outside of class and reading the quiz, you are more informed and you get what has been taught more. And you get a better understanding of what is being taught in class." "The reason for me doing the quizzes was to help me with my studying. To improve my marks in the exam. To prepare myself for the exam really. The quizzes were part of my studying for the exam." "Yeah, I found this method of studying using the quizzes really helped me. It really helps." "Yeh the short questions helped too. All of the questions actually helped. They helped me know what you were talking about in class. It kind of focused me a little bit and helped me revise. For the studying and for the exam it helped." " if you could attempt it again and the second time you did very good and then you get a better grade overall and you are more motivated."
Characteristics of the Quizzes	in the final exam. So they were pitched at the right level." "Anything that was over 30 minutes I would lose interest in and not do." "In terms of question design, there was one question where I answered 'MIS' and got it wrong. The correct answer was 'Management Information Systems', which of course is the same thing. This was frustrating." "No prescribed answer for open ended questions, even with feedback, was not ideal." "For objective questions, getting it wrong and being given the correct answer was almost more beneficial than getting it right." "The content was good." "I liked the short questions. MCQ. If you got it wrong you wanted to know why."	"Length was good. 10-15 questions, and short questions." Quality was good. [Referring to Learnosity quizzes]. "Content was fine."	"Length was ok. Interesting or not? Study is work."	"Not too long or too short. If you study it was easy enough." Towards the end of the longer tests (40 questions) I was getting a little bored. That was a bit too much. 30 was a good number of questions.	[No direct quote provided]	"Length was fine. Difficulty: Not too hard."	"The length was fine wasn't too long or too short."	"The last quiz was very good. Because you have to fill in the gaps." "The one where you typed in a longer theory answer or even a short answer or a word, they were the best ones for me." "In the first semester, there were a lot of questions. Some of the quizzes were really long. It was really very boring and tiring sometimes." "The quizzes were very long in semester 1 but I still saw benefits for studying and for the exam." "the last one in the second semester, there was way less questions, just the right amount of questions, which was really great. I think there were just 10 questions. It wasn't boring. It was really great and really engaging." "They were not too easy. They were just informative and educative." "the level was good." "The drag and drop [Learnosity] one, I think it's just really interesting. I liked that one." "what I can say is that the last one was really perfect."
Feedback and Impact on Learning	"Yes, and the feedback would say for example "read section 3.2 in the book". But i was unclear to me where exactly the feedback was referring to - it was not specific enough. "Objective questions were better for study - right and wrong answers helped me study." "When i got something wrong, it showed me where I got it wrong. This was the advantage of objective questions over subjective/open ended questions." "I didn't spend time reviewing the feedback after the fact." "When the subjective questions were answered, I didn't always go back to read the feedback."	"Used the quizzes after I had done the bulk of my study. I used it as a gauge to how well I was getting on with the material."	"I was working out what topics I would do in the exam." "I never saw the feedback. Once I did the quiz, I never went back in. I ignored the feedback."	[No direct quote provided]	"These topics (MIS etc.) are broad. So if I could recall the correct answer to a multiple choice, it helped me in my essays in the Final Exam later. I could construct sentences around the one fact I remembered from say an MCQ. So it's worthwhile having short questions too."	"When I got it wrong I would take note of the correct answer and write it down. Then I would remember the right answer."	"When I didn't know the answers I would write it down as a topic to study."	feedback sometimes. But the second semester one was improved." "It was very helpful getting the right answer because sometimes I don't know the answer. So that's informing and I know what it's supposed to be and what I need to do straight away." "The waiting one, you know the one you have to wait for the answer - some people don't like the waiting one. You have to come back and check if the answer has been graded and the right answer has been given. But some people will not go and check because it takes too long and it's too much hassle. I checked back a few times and there was no answer there afterwards. But I don't mind checking back so I went back in actually, it was frustrating but I went back in. Some of my classmates said no, once they did the quiz, that was them done. They didn't didn't ever go back and check for the answers. They never opened it up again." "The immediate feedback is good to check if it was the answer you were expecting." "Immediate feedback is important. But most of them don't go back and check the feedback, but they know themselves how they did in the quiz." "if you do it one time, then you will look at your feedback. And then you can do it again. And now do good."
Suggestions for Improvement	"feedback...not specific enough"	"The subjective (open ended) questions - I could see why they were there." Had to drag an answer into a box, and it was a little confusing.	"Would be good to have pdf export of the open ended sample answers for later help with studying."	"The subjective (open ended) questions I could see why they were there."	"You tried to cover way too much content in a semester." "So need to highlight the bits you really need to know. Both when setting the curriculum but in the quizzes." "I think you need to focus us more on certain topics to really focus on."	"Yes/ no answers won't show in the exam but they are helpful for studying." "But the exam is essay style/open-ended."	"Quicker responses with subjective questions. Maybe sample answers so I had an idea of what I was supposed to have answered more immediately." "I didn't mind the open ended questions but I don't know if I got them right or wrong."	"In terms of improving the quizzes overall, it would be better if there would be quicker feedback. And more question types and structured like that last quiz." "Yeah, maybe make it small, make it shorter. Maybe 10 questions or a maximum of 15. If you got up to twenty something, then that would put them off, but 10 to 15, that would give them immediate feedback on how well they know the topic."
Incentivisation for Engagement	"5 modules x 2% each." "Do them as a written test in class. This prevents anyone googling the answers." "To do it in each module, forces the student to focus on modules the might otherwise have skipped." "If you were told on day 1 of each topic, that the quiz was open for the duration of the topic. And you could attempt as many times as you like. Then at the end of the topic I would give similar, not the same, questions as a Continuous Assessment."	"Make it worth 5%." "People not going to do it for nothing. However the same people that won't do it, won't do it for 5%." "If you need time to do it in class, don't do a roll call. This takes 5 minutes to do a quiz, and the quiz can double as the roll."	"I think it should count towards my Continuous Assessment."	[No direct quote provided]	grade." "If there was an incentive, say it was worth 5% of my mark, I might have engaged more." "I would make this a part of my Continuous Assessment grade, counting towards my final mark. 5% or more would be enough to incentivise me. 1% per quiz." "There was another course that gave us 15% of the final mark for a quiz. This was very incentivising. I'd say about 98% of the class did it and got their percentage." "If it's being incentivised by being included in a Continuous Assessment mark, it doesn't need to take up lab time, you	"People not going to do it for nothing." "it would have to be supervised."	"It's a very useful tool in studying. There should be no need for incentives."	"Another way to encourage them is to maybe allocate some marks, like one or two marks per quiz." "I would say if there's five quizzes, and you got 1% per quiz, that would be 5% overall. Yeah, that's a lot. And it is benefitting your studying too."
Device Used for Quizzes	"my computer"	"Laptop or PC."	"Mixture of iPad, and laptop." "I did not use my phone because it eats my battery, and the ipad is bigger. The phone is too small."	"We'll definitely be on a laptop."	"My computer."	"Was through Moodle on the Moodle app on computer."	"My own laptop. Phone was too slow, and kept freezing."	[No direct quote provided]
Location of Quiz Completion	"I just did at home on my computer. Okay. I tried it one time on my phone but I thought it was too small."	"In library or home."	"Mixture of iPad, and laptop. I would do the quizzes while traveling back and forth to college."	[No direct quote provided]	"I just did at home." "Okay. I tried it one time on my phone but I thought it was too small."	"At home rather than on college campus."	"At home on my own laptop."	"I do the quizzes when I have some free time. The times when I'm in the college, I did them on the PC in the computer labs. When I am in the Library, I do them on the PC there. But sometimes when I'm home, or maybe just in bed just studying, I use my phone."

E3: Correlation Data (SPSS) (ARC2)

Correlations

			AR2 attendance2	AR2 theory	AR2 grade	AR2Fq8 Grade100	AR2Fch10 Grade100.00	AR2Fch13 grade25	Ar2ch6 Lscore	ar2 ch12 score
Spearman's rho	AR2attendance2	Correlation Coefficient	1.000	.137	.353**	.161	.344	.227	.382	.324
		Sig. (2-tailed)	.	.143	.000	.362	.058	.416	.060	.163
		N	115	115	115	34	31	15	25	20
	AR2theory	Correlation Coefficient	.137	1.000	.745**	.064	.267	.241	.287	.242
		Sig. (2-tailed)	.143	.	.000	.720	.147	.388	.164	.303
		N	115	115	115	34	31	15	25	20
	AR2grade	Correlation Coefficient	.353**	.745**	1.000	.134	.395*	.629*	.279	.339
		Sig. (2-tailed)	.000	.000	.	.449	.028	.012	.177	.144
		N	115	115	115	34	31	15	25	20
	AR2Fq8Grade100	Correlation Coefficient	.161	.064	.134	1.000	.393	.466	.336	.437
		Sig. (2-tailed)	.362	.720	.449	.	.064	.149	.285	.155
		N	34	34	34	34	23	11	12	12
	AR2Fch10Grade100.00	Correlation Coefficient	.344	.267	.395*	.393	1.000	.586*	.472	.789**
		Sig. (2-tailed)	.058	.147	.028	.064	.	.045	.169	.007
		N	31	31	31	23	31	12	10	10
	AR2Fch13grade25	Correlation Coefficient	.227	.241	.629*	.466	.586*	1.000	.100	.757*
		Sig. (2-tailed)	.416	.388	.012	.149	.045	.	.873	.030
		N	15	15	15	11	12	15	5	8
	Ar2ch6Lscore	Correlation Coefficient	.382	.287	.279	.336	.472	.100	1.000	.359
		Sig. (2-tailed)	.060	.164	.177	.285	.169	.873	.	.430
		N	25	25	25	12	10	5	25	7
	ar2 ch12 score	Correlation Coefficient	.324	.242	.339	.437	.789**	.757*	.359	1.000
		Sig. (2-tailed)	.163	.303	.144	.155	.007	.030	.430	.
		N	20	20	20	12	10	8	7	20

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

E4: Quiz Answer Analysis (ARC1)

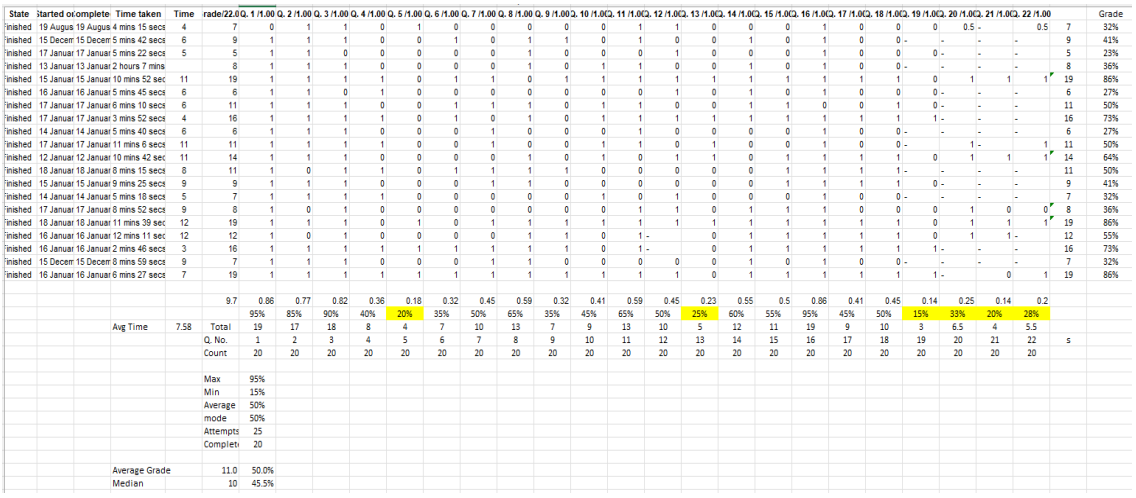


Figure 48 Quiz Answer Analysis – Low Scoring Questions Highlighted (ARC1)

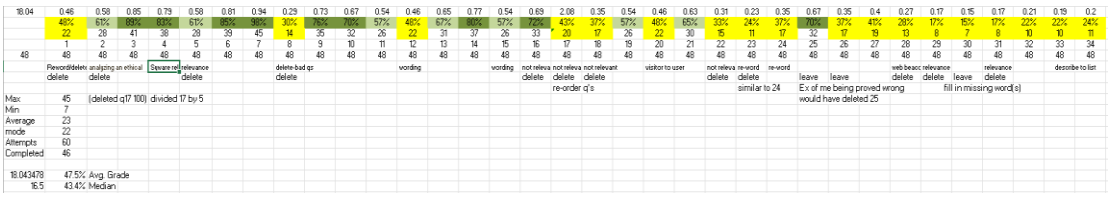
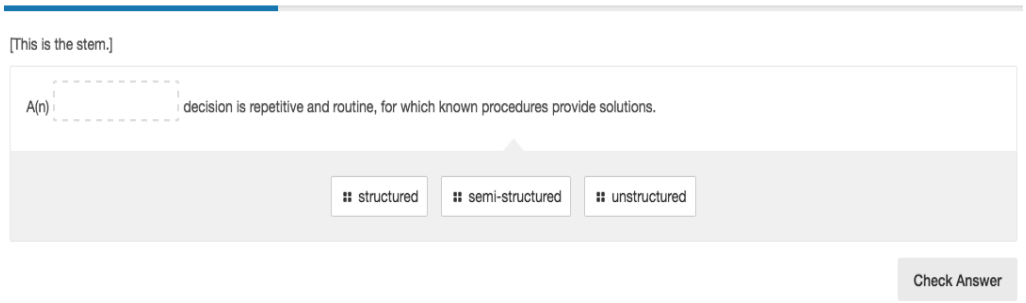


Figure 49 Quiz Answer Analysis (ARC1)

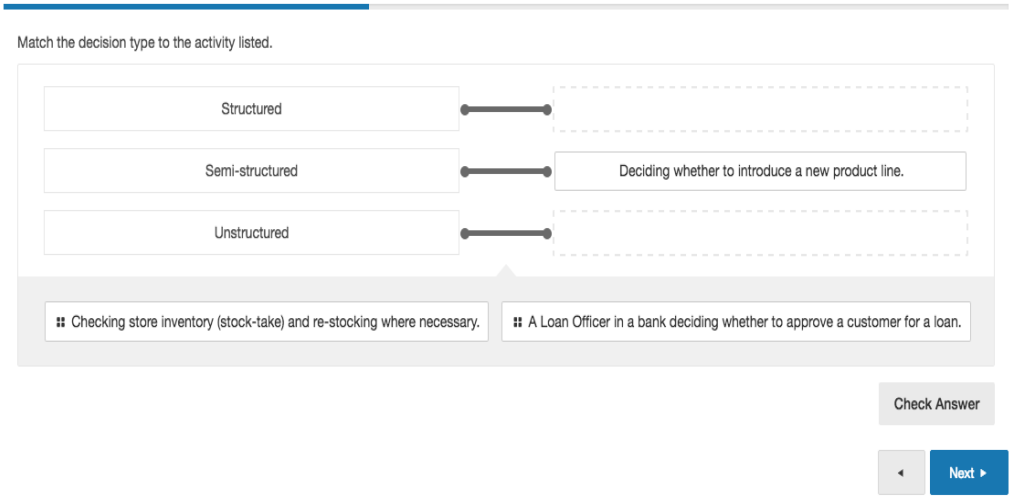
Note: As above with notes as to how to improve for next ARC

Appendix F: TEFA/Intervention Materials

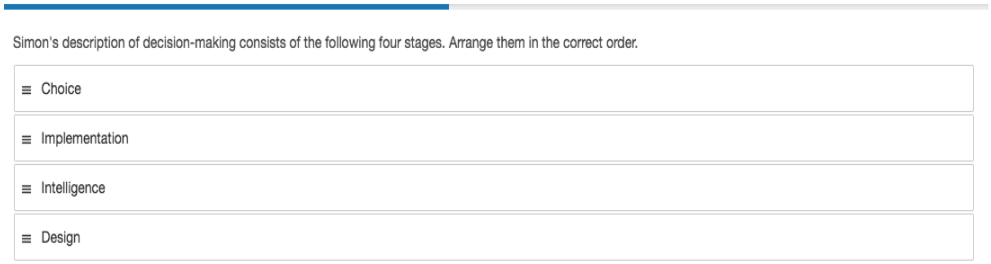
F1: Samples of Technology-Enhanced Formative Assessments



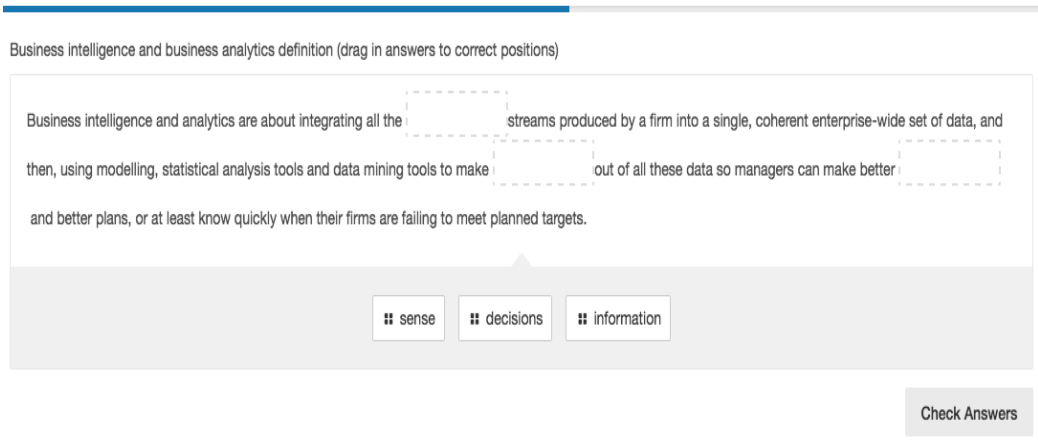
Sample Learnosity Fill in the Blank (Drag & Drop with Check Answer button)



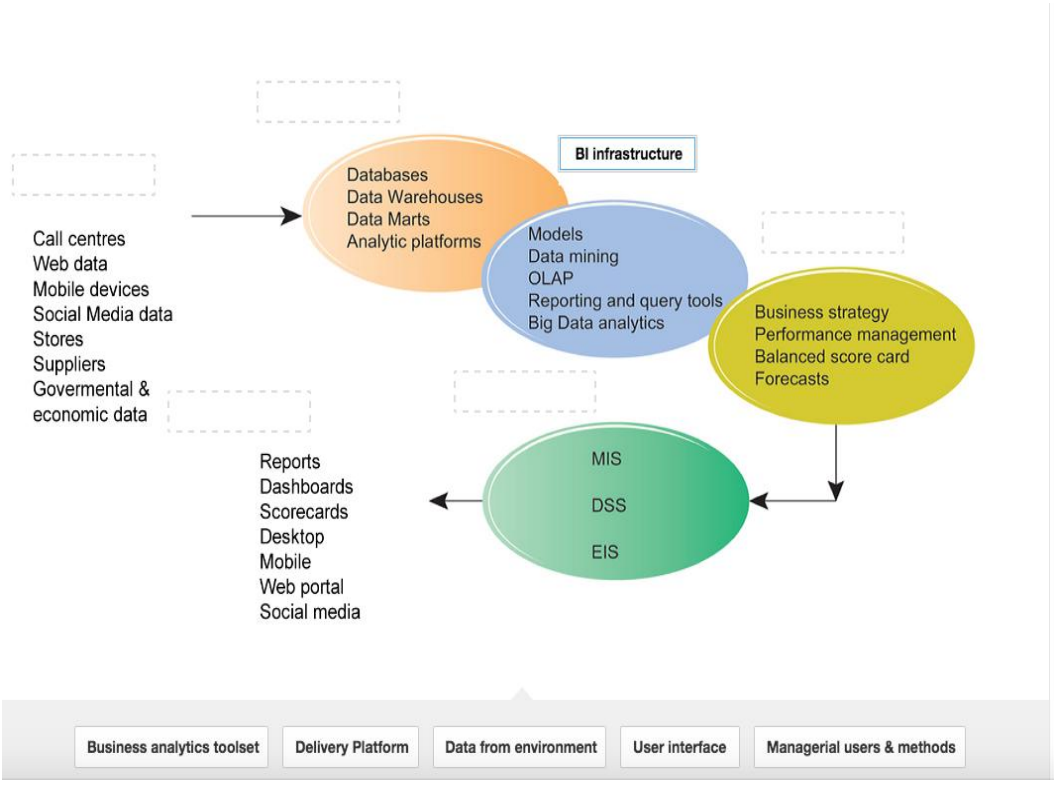
Sample Learnosity Match List (Check Answer button)



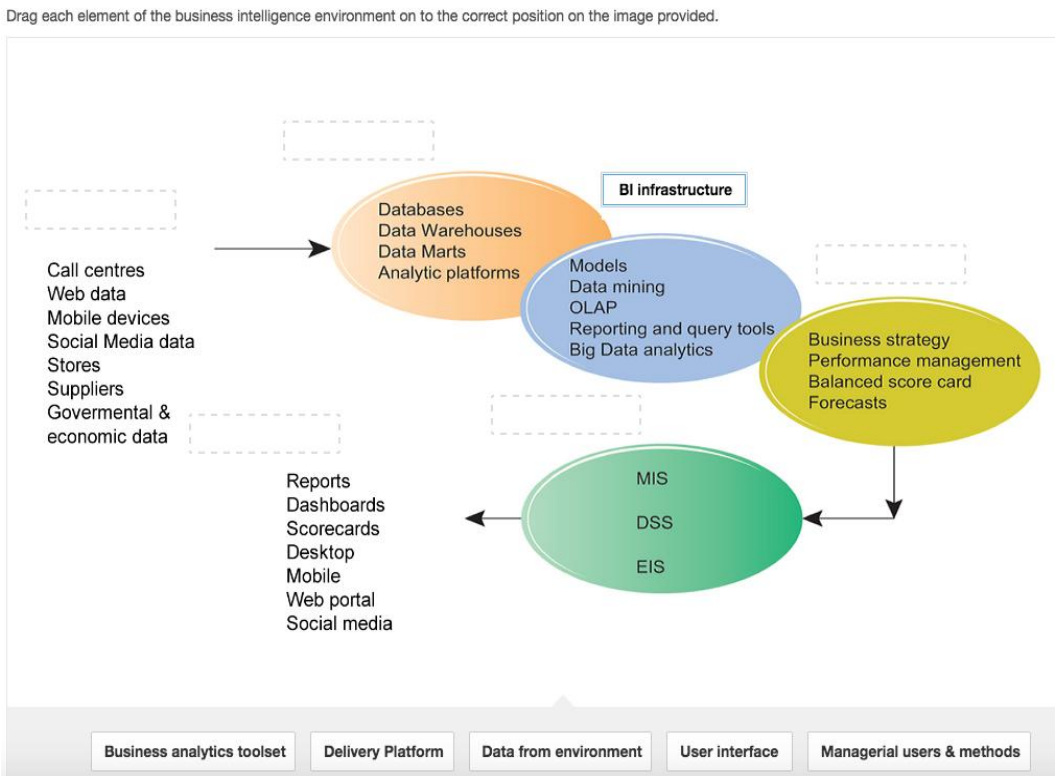
Sample Learnosity Order List



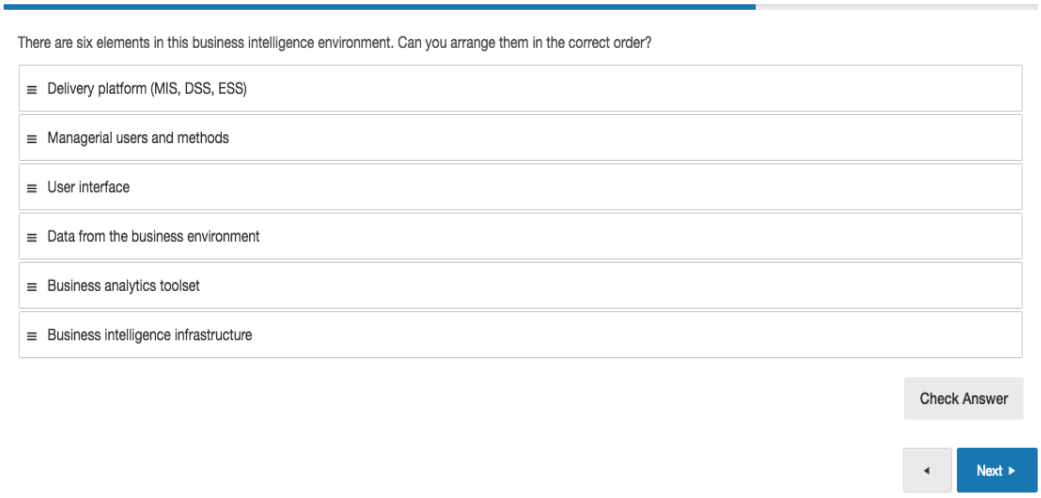
Sample Learnosity Fill in the Blank (Check Answer button)



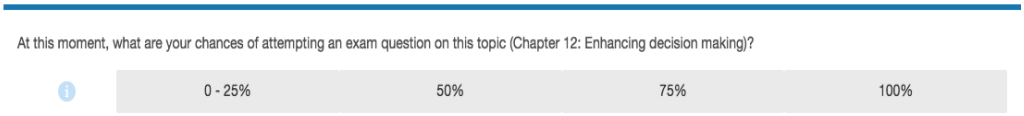
Sample Learnosity Match List



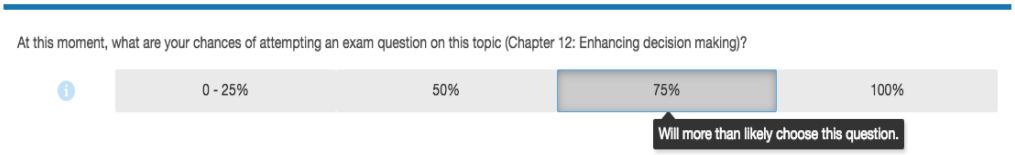
Sample Learnosity Match List



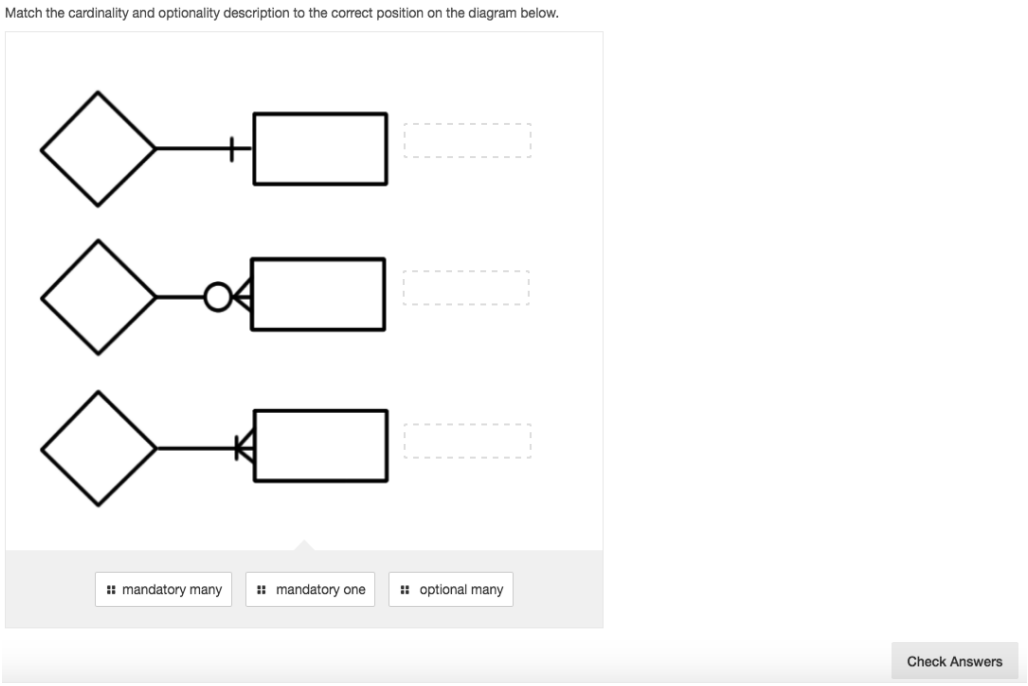
Sample Learnosity Order List (Check Answer button)



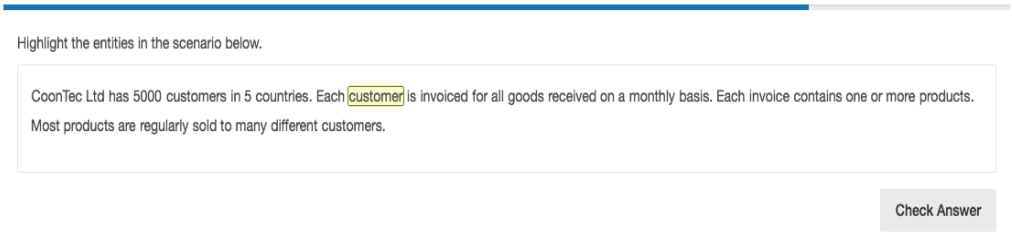
Sample Learnosity Multiple Choice (Metacognition)



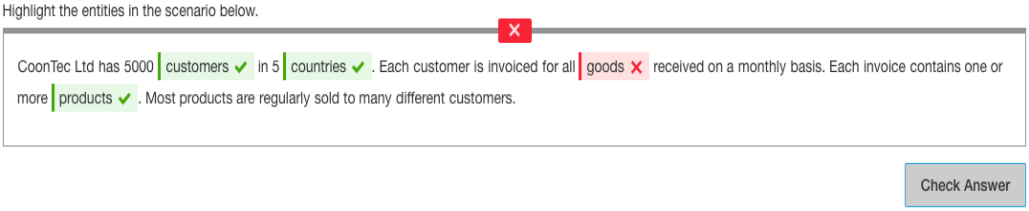
Sample Learnosity Multiple Choice (Metacognition)



Sample Learnosity Match List (Static and Dynamic List)



Sample Learnosity Highlight Text (Check Answer button)

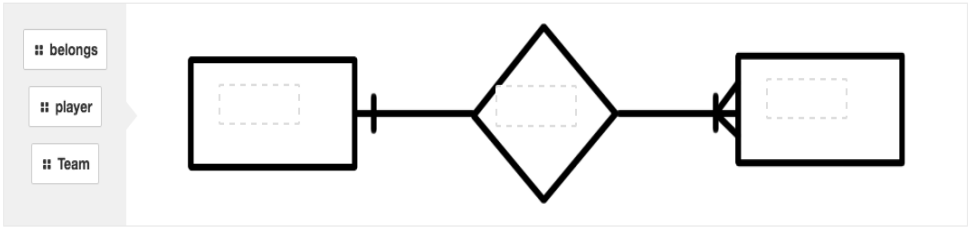


Sample Learnosity Highlight Text (Check Answer button)

If you were creating a database that models soccer teams and the players in each team. You want to capture the following:

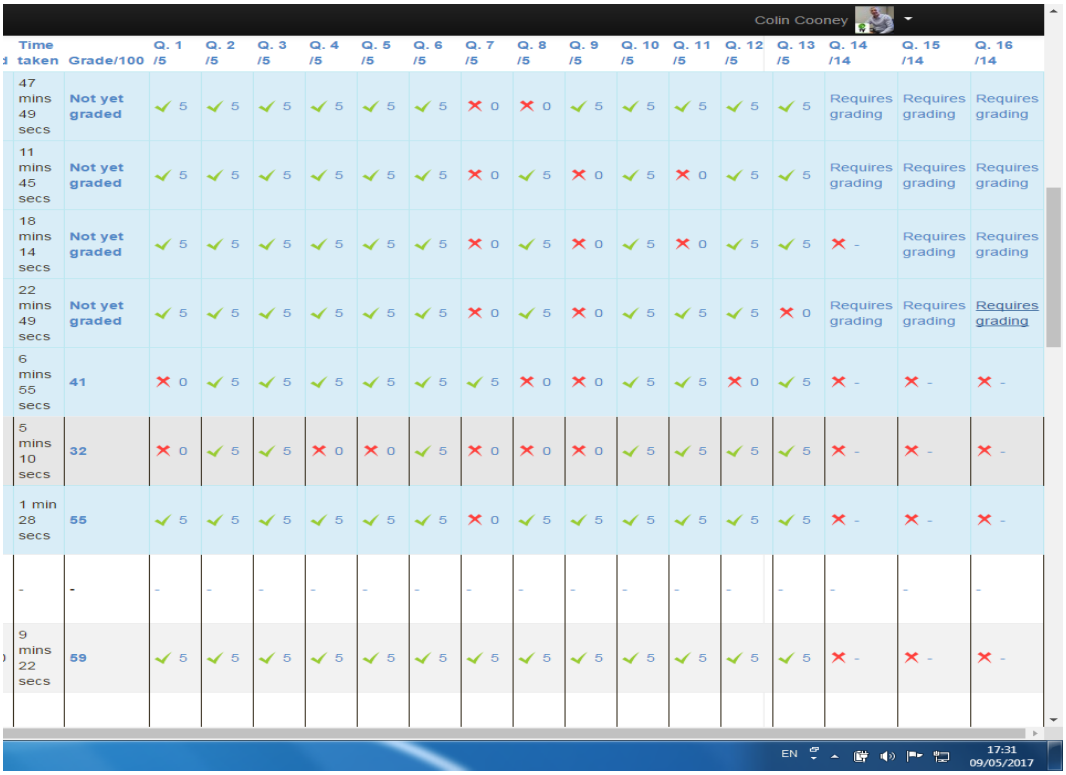
- There are a set of teams, each team has an ID (unique identifier), name, main stadium, and to which city this team belongs.
- Each team has many players, and each player belongs to one team. Each player has a number (unique identifier), name, DoB, start year, and shirt number that he uses.

On the diagram below, drag in the words to the correct parts of the diagram. Also, you should use this example as practice for the exam.



Sample Learnosity Match List

Appendix G: Samples of Grading and Feedback

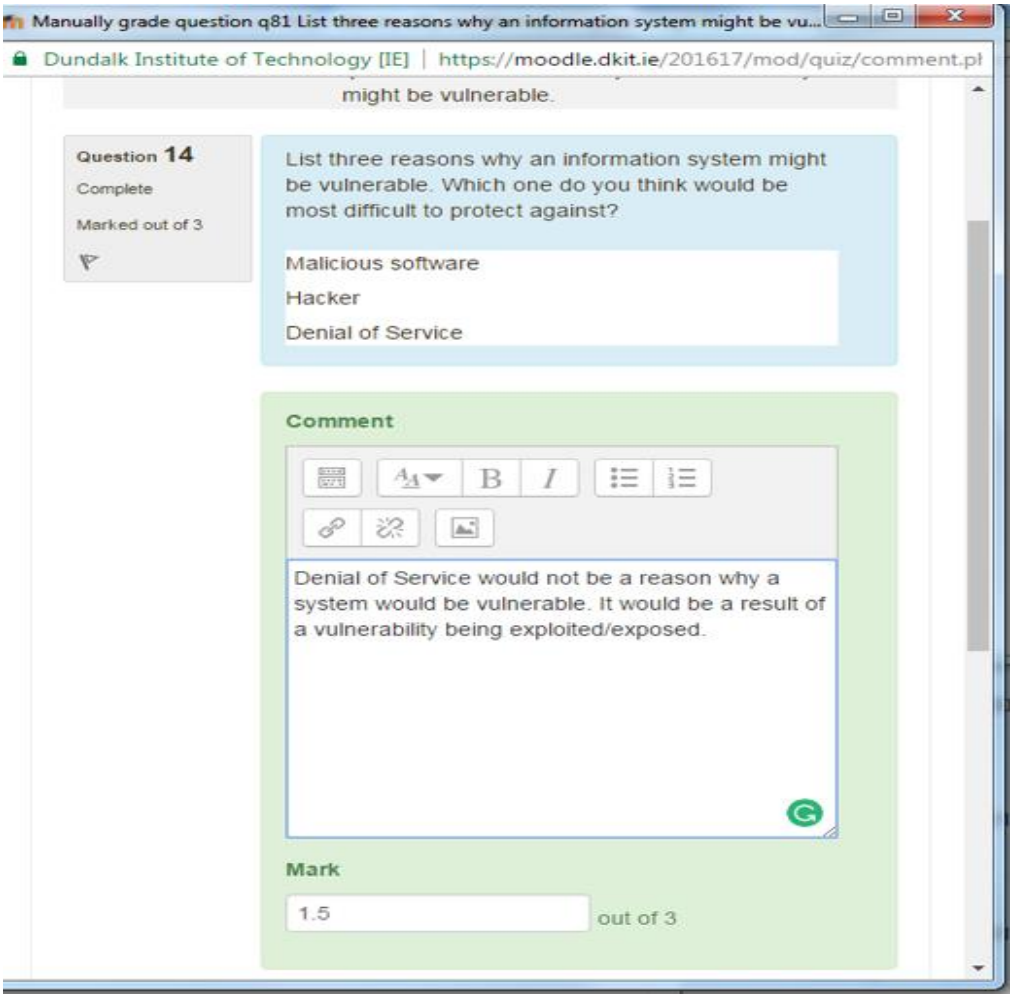


Colin Cooney

Time taken	Grade/100	Q. 1 /5	Q. 2 /5	Q. 3 /5	Q. 4 /5	Q. 5 /5	Q. 6 /5	Q. 7 /5	Q. 8 /5	Q. 9 /5	Q. 10 /5	Q. 11 /5	Q. 12 /5	Q. 13 /5	Q. 14 /14	Q. 15 /14	Q. 16 /14
47 mins 49 secs	Not yet graded	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ 0	✗ 0	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	Requires grading	Requires grading	Requires grading
11 mins 45 secs	Not yet graded	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ 0	✓ 5	✗ 0	✓ 5	✗ 0	✓ 5	✓ 5	Requires grading	Requires grading	Requires grading
18 mins 14 secs	Not yet graded	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ 0	✓ 5	✗ 0	✓ 5	✗ 0	✓ 5	✓ 5	✗ -	Requires grading	Requires grading
22 mins 49 secs	Not yet graded	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ 0	✓ 5	✗ 0	✓ 5	✓ 5	✓ 5	✗ 0	Requires grading	Requires grading	Requires grading
6 mins 55 secs	41	✗ 0	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ 0	✗ 0	✓ 5	✓ 5	✗ 0	✓ 5	✗ -	✗ -	✗ -
5 mins 10 secs	32	✗ 0	✓ 5	✓ 5	✗ 0	✗ 0	✓ 5	✗ 0	✗ 0	✗ 0	✓ 5	✓ 5	✓ 5	✓ 5	✗ -	✗ -	✗ -
1 min 28 secs	55	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ 0	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ -	✗ -	✗ -
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 mins 22 secs	59	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✓ 5	✗ -	✗ -	✗ -

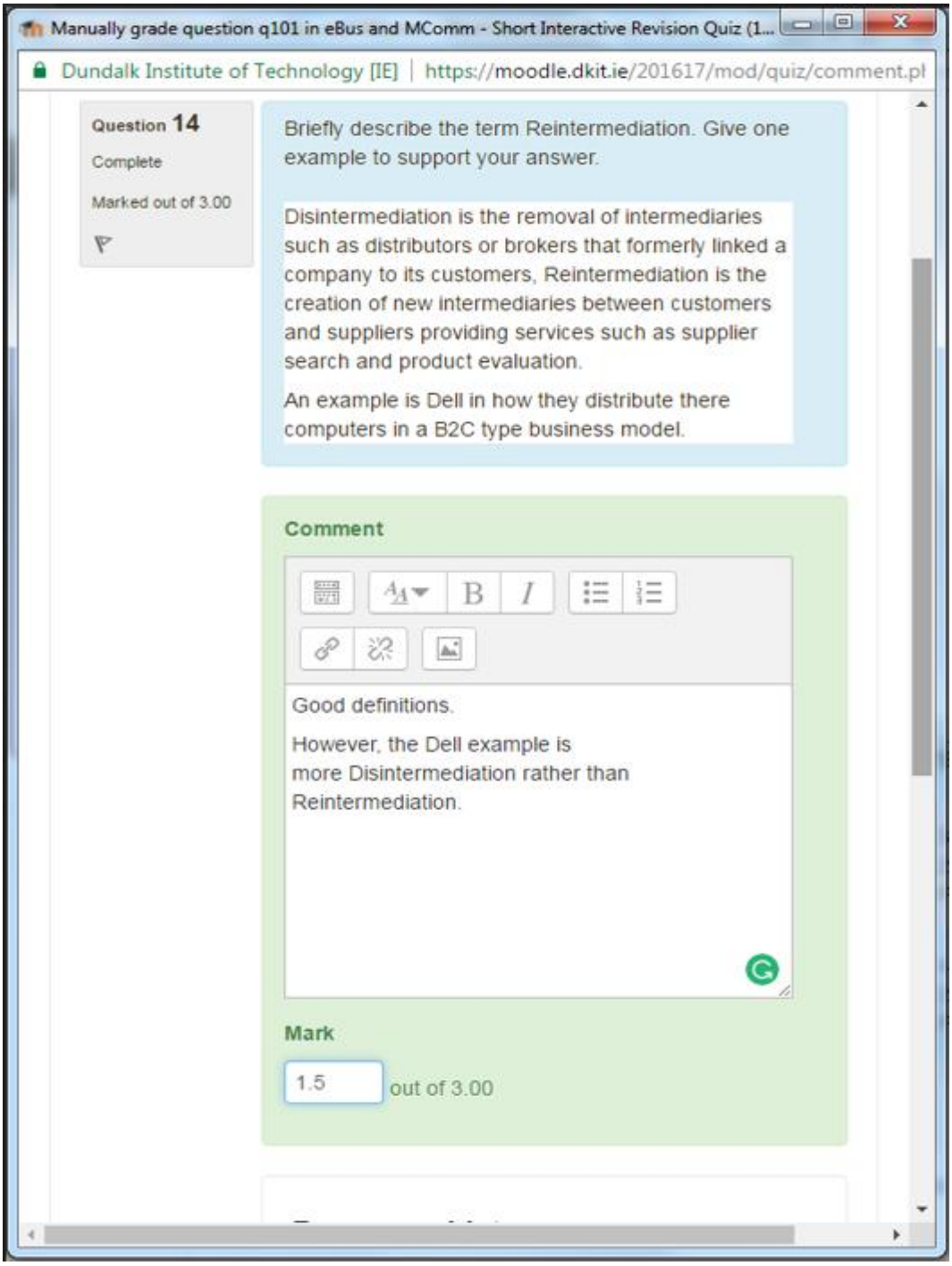
EN 17:31 09/05/2017

Moodle MCQ Grading (ARC3)



Moodle Essay Question Grading (ARC3)

Moodle MCQ and Essay Grading (ARC3)



Moodle Essay Question Grading (ARC3)