Recognizing professional development of mathematics and statistics learning support staff

Ciaran O'Sullivan[†], Michael Grove[‡], Ciarán Mac an Bhaird[§,*], Peter Mulligan[§] and Kirsten Pfeiffer[‖]

[†]*School of Mathematics and Statistics, Technological University Dublin, Dublin, Ireland*
[‡]*School of Mathematics, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK*
[§]*Department of Mathematics and Statistics, Maynooth University, Maynooth, Co. Kildare, W23 HW31, Ireland*
[‖]*School of Mathematical and Statistical Sciences, University of Galway, Galway, Co. Galway, Ireland*

[*]*Corresponding author. Email:* ciaran.macanbhaird@mu.ie

Tutors play an important role in effective Mathematics Learning Support, and ensuring good initial training and development is key. Typically, in the UK and Ireland, tutors do not gain any formal recognition for the training they receive. This paper details a four competences model of training for tutors and presents the analysis of feedback from 11 tutors and two staff involved in piloting the model at two institutions. The model, which is informed by professional development guidelines, consultation across the mathematical sciences community, and enabled by a national Mathematics Learning Support Network, provides immediate recognition of the professional development undertaken and is amenable to formal accreditation. A structure of four digital badges is used to assign immediate value to the training and development of tutors. To add further value for tutors, a capstone tutor badge has been established for those completing all four competences. Thematic analysis of feedback from the piloting of the model identifies three overarching themes: the importance of community, developing as a professional, and motivating and enabling professional development. Although primarily of interest to those involved in Mathematics Learning Support, the innovative structure of the model and the insights gained from its piloting are such that it offers potential for genuine transferability across other subject disciplines.

1. Mathematics Learning Support: responding to the mathematics problem

The origins and evolution of the mathematical issues and challenges experienced by students in higher education, the so-called mathematics problem, are well described (LMS, IMA & RSS, 1995; Sutherland & Pozzi, 1995; Hawkes & Savage, 2000). By drawing together a range of national reports, Lawson *et al.* (2020) provided a detailed overview of the key issues now identified with student learning of

mathematics in a range of discipline areas and involving students beyond the transition to university study. They identify issues in diverse discipline areas including the arts, humanities, health and social sciences, as these subjects have become increasingly quantitative.

One major response to 'the mathematics problem' has been the establishment of mathematics and statistics learning support (MLS). Lawson *et al.* (2003, p. 9) describe MLS as a *'facility offered to students . . . which is in addition to their regular programme of teaching, lectures, tutorials, seminars, problems classes, personal tutorials, etc.'*; that is, it does not form part of the core or compulsory curriculum of the programme that the student is studying. Marr & Grove (2010) demonstrate how MLS can be offered to students in a range of different forms including on a drop-in or appointment basis, in small groups or one-to-one, with a now widely adopted approach being that of a mathematics support centre that students can visit to receive help with their mathematical learning.

During its early days, MLS was typically focused upon STEM students struggling with their mathematical learning at the transition to university study. However, as Lawson *et al.* (2020, p. 26) highlight within their review of relevant literature, *'mathematics support has rapidly evolved'*, and in particular *'it has evolved from being a remedial service to being about enabling enhancement of learning for all students, with provision now widely available to, and accessed by, a range of learners'* (Lawson *et al.*, 2020, p. 24). There is now a significant body of evidence detailing its effectiveness on student retention and progression (Matthews *et al.*, 2013; Lawson *et al.*, 2020), with perhaps the most powerful being provided by O'Sullivan *et al.* (2014) who identified in their large-scale survey (nine institutions and 1633 students across the island of Ireland) that some 63% of the MLS users surveyed who had considered dropping out of university felt that accessing MLS had positively influenced their decision to continue with their studies.

The widespread growth of MLS, that is, the number of institutions offering some form of provision, within higher education is now well documented. Recent surveys report the extent of MLS provision in England and Wales (Grove *et al.*, 2020a), Scotland (Ahmed *et al.*, 2018), across the island of Ireland (Cronin *et al.*, 2016), and internationally within Australia (MacGillivray, 2009), the USA (Mac an Bhaird & Thomas, 2023) and Germany (Schürmann *et al.*, 2020). Universities themselves also now place great emphasis upon MLS as an important part of their student experience. In their recent work Croft *et al.* (2022) analyse a series of institutionally written regulatory documents within England and in doing so identify how universities themselves now recognize the important role that MLS has in their retention, achievement, employability and widening participation activities.

2. The Important Role of the Mathematics Support Tutor

The greatest benefit of a mathematics support centre is the availability of the focused support that it offers as an immediate response to the mathematical difficulties a student may encounter. The role and actions of the tutors working within it are the most crucial aspects in the learning experience that the student receives. As Grove & Croft (2019, p. 229) comment: *'their role consists of working with students, typically on a one-to-one basis, to try and understand their mathematical problems and then offering advice, guidance, motivation and support to help the student successfully work through these issues'*. Unlike tutoring on a more traditional course or module, mathematics support tutors need a broad subject knowledge and the ability to engage in mathematical problem solving in real time, and with the student present, since queries are rarely predictable.

However, there is much more to the role. There is also a need for tutors to build a positive learning environment with the student at its centre. As Grove *et al.* (2019, p. 6) put it: *'it is not tutoring, it is not small group teaching, it requires communication skills, human empathy and the ability*

to allow other people to work and fail but within a supportive and non-judgmental environment; it is the ability to guide independent learning.' These views are echoed by the student users of mathematics support. For example, Fitzmaurice & Mac an Bhaird (2021, p. 11) note in their study that '... *users of MLS have high expectations of the standards a tutor should reach in a one-to-one situation*'.

Further, those tutoring in MLS work with some of the most vulnerable students, for example, those lacking confidence, with specific learning differences or most at risk of dropping out. However, there now exists evidence that the specialist and more able mathematics student, often in the later years of their studies, is increasingly accessing MLS as a means of further developing their mathematical skills and knowledge (Grove *et al.*, 2020b). Given the diverse nature of the students who might access MLS for assistance with their mathematical learning, the training of tutors to cope with their individual demands and expectations requires careful consideration and implementation.

3. Towards a Framework for Accredited Tutor Training

Within MLS, the primary resource for supporting and enhancing student learning is that of the tutor. Whilst there is now a wider range of staffing models for delivering MLS within institutions in the UK and Ireland, suitably capable postgraduate students, predominantly those studying PhDs within the mathematical sciences or related disciplines, remain one of the most common, particularly in research-intensive universities (Grove *et al.*, 2020a). However, as Grove *et al.* (2019) describe, at least within the UK and Ireland, it was historically the case that despite postgraduate students having an important role supporting student learning within the mathematical sciences at university level, they received little training for the position.

In more recent times, structured models of MLS tutor training have become successfully established (not entirely independently) in Ireland and the UK, and are delivered by individuals grounded in the disciplines of the mathematical sciences. These training models represent an evolutionary approach and span a spectrum of opportunities including informal discipline-specific training and events, typically workshops, and currently culminate in a structured and nationally recognized model in Ireland. Details of these models and their impact are discussed in detail in Grove *et al.* (2019). Whilst they represent successful approaches to providing new tutors with initial training and support in teaching and learning, a more significant challenge has been structuring the activities in a way that enables new tutors to receive some form of recognition for their endeavours. This is important from a personal perspective to ensure tutors possess recognized evidence of their own academic development, but also for institutions in evidencing that appropriate training has taken place to ensure any regulatory requirements can be met.

A substantive issue affecting the uptake of training provision delivered by a community of expertise is the lack of a mechanism for aligning this subject-specific provision against the relevant national quality standards such as the UK Professional Standards Framework (2011). However, it is worth noting that these standards have recently been updated to include a much more overt emphasis on the context in which the teaching takes place (UK Professional Standards Framework, 2023). The *National Professional Development Framework for All Staff Who Teach in Higher Education* (National Forum, 2016), on the other hand, does offer some ideas for how best to align such a training model so that it is more amenable to accreditation by considering a '*Typology of Professional Development Activities*'. This typology, which also contains suggestions for implementation, ranges from non-accredited (including collaborative, unstructured and structured) approaches to those that are formally accredited via recognized provision and an appropriate organization or national body.

3.1 Developing a Training Model Based Upon Community Consultation and Feedback

In 2016, members of networks of MLS practitioners within the UK and Ireland began considering the needs and challenges of introducing models of recognized training for those new to tutoring, which would allow progression from the present structured but non-accredited systems to one that can be readily accredited by an appropriate body. To aid this process a prototype model for a recognized professional qualification for MLS tutors was initially introduced by the first author at the 10th Irish Mathematics Learning Support Network (IMLSN) annual conference (IMLSN 10), which itself had a focus on the key role of tutors in mathematics learning support (Pfeiffer *et al.*, 2016).

Community feedback on this approach was sought from the participants at IMLSN 10 as part of a set of interactive tasks during the keynote session. The participants in these tasks (24 in total) were from a cross-section of the 16 institutions present at the conference and consisted of a mixture of tutors, MLS managers, lecturing and support staff. Whilst positive overall, 14 participants encouraged further development and piloting of the model, with participant feedback noting three key issues and challenges requiring attention if the model were to be successful:

- Flexibility in the training structures (schedule, timing, etc.).
- The extension of the model to capture the training needed by postgraduates in mathematics teaching and the training of non-disciplinary specialists (for example, postgraduate students in engineering) who might also be assigned to mathematics teaching duties.
- Formal accreditation of the training (who provides accreditation, how is the work validated, how is it aligned with existing accreditation structures).

Arising directly from IMLSN 10, a working group was established to progress the development of the prototype model. As part of this, the group undertook further consultation and discussion with the MLS community. For example, a workshop entitled *A system of tutor training which facilitates formal accreditation* was held at the CETL-MSOR conference in Glasgow in September 2018 and provided valuable insights regarding recognition and accreditation. This was followed in April 2019 by a National Forum National Seminar Series workshop entitled *Accrediting systems of training for postgraduate tutors and lecturers in STEM*. This workshop specifically explored how the described approach to training could be applied efficiently across the island of Ireland, with the feedback generated being used to inform how the training model might be funded, sustained and supported in a constantly evolving HE landscape.

We now go on to describe the *Four Competences Model for MLS Tutor Training*, which forms the outcome from this work undertaken with the MLS community, and report on the evaluation of a pilot programme of training activity undertaken within two higher education institutions within Ireland. Although applied here in the context of MLS, it more generally provides a transferable framework for those wishing to develop programmes of disciplinary-based training, for example, in other STEM subjects, in business, economics, etc.

3.2 The Four Competences Model for MLS Tutor Training

The *Four Competences Model for MLS Tutor Training* is a training and recognition framework with the three principal aims to:

1. Provide the training needed for an MLS tutor and promote the application of this learning to enhance the experience of students using MLS.
2. Provide a rich variety of development opportunities for tutors to encourage engagement with the model and to seed good professional development habits.

3. Provide a mechanism to enable immediate recognition of the quanta of learning achieved in a way that tutors can record for career purposes and disseminate via professional social networks.

As its name suggests, the authors identified four key competences that the model seeks to instil and recognize within tutors working in MLS. These competences are based upon the aspects of MLS tutoring roles that are known to be most important in terms of supporting student mathematical learning:

- *MLS Knowledge and Skills:* the ability of the tutor to: recognize the typical mathematical ability of students who require MLS; interact effectively with users of MLS through the application of appropriate teaching and learning approaches; recognize both the implications of the non-academic differences between users of MLS and the range of situations that can occur as a result of diverse student approaches to learning.
- *Communication/Dialogue skills:* the ability of the tutor to: apply the skills in explaining, listening and questioning necessary to employ positive strategies of engagement with users of MLS; engage in constructive peer review of MLS research; participate in relevant MLS community/forum activities.
- *Professional Identity Development:* the ability of the tutor to: employ a framework of knowledge and techniques to develop as tutors within their future work in MLS.
- *Digital Capacity:* the ability of the tutor to: demonstrate a knowledge of ways in which technology has been used to enhance learning in mathematics; employ digital tools and techniques to support learners using MLS.

To enable the model to successfully deliver its three aims, the following key features of design and implementation were identified after consultation with the MLS community as discussed in Section 3.1. To be successful, the model seeks to:

a) Be aligned with national professional development guidelines and frameworks.
b) Be structured with sufficient granularity to allow for the study/work demands and time constraints of tutors.
c) Allow for local adaptation to ensure that needs and cultures of MLS provision in diverse institutions can be accommodated.
d) Ensure that the evidence of learning is collected and validated so that tutors can seek formal accreditation by institutions (academic or professional) using recognized prior learning mechanisms.
e) Make best use of existing tutor training materials and the extensive experience of the MLS practitioner communities.
f) Ensure that the administration associated with the process is streamlined so as not to overburden the local MLS coordinator who is best placed to oversee the learning associated with the MLS tutor training opportunities.

To maximize the professional development potential of tutors participating in MLS training, the model is aligned with the *Irish National Professional Development Framework for All Staff Who Teach in Higher Education* (National Forum, 2016) given that this framework affords the flexibility for establishing provision that is nationally recognized and accredited. This National Forum framework was established as a result of an extensive international examination of the flexible frameworks for staff professional development and an associated consultation at a national level (O'Neill *et al.*, 2016; Donnelly & Maguire, 2020). To further aid the transferability of the developed model, a high-level mapping to the three dimensions (Areas of Activity, Core Knowledge and Professional Values) of the UK Professional Standards Framework (2011) and each of the four competences was also undertaken, see Appendix A.
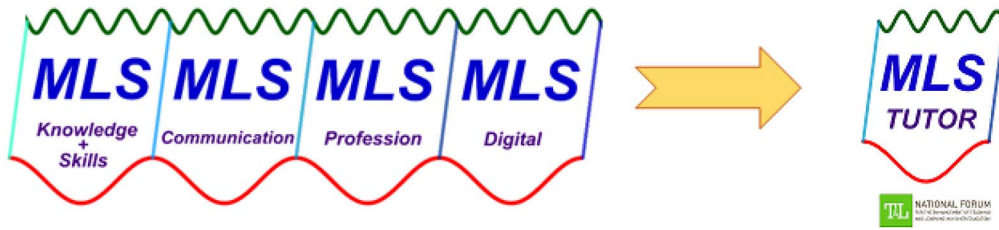
FIG. 1. MLS tutor development digital badges.

For each of the four competences, a micro-credential, in the form of a digital badge, was developed and is awarded to tutors who successfully demonstrate their completion of the learning outcomes associated with each competency. Each digital badge is designed so that it can be completed independently, but when the four are combined, they form an overall award, recognized by the National Forum for the Enhancement of Teaching and Learning in Higher Education, of 'MLS Tutor', see Fig. 1. This award is made as part of its open access digital badge initiative (National Forum, 2021a) and allows transferable recognition of the skills, knowledge and abilities that an individual possesses or demonstrates (National Forum, 2021b).

This National Forum mechanism provides recognition of professional development but not formal accreditation. To afford a tutor the opportunity to seek formal accreditation, by either their institution or professional organization via a recognized prior learning mechanism, each digital badge has a suggested value of ECTS (European Credit Transfer and Accumulation System) credits at either Level 9 or Level 10. Two ECTS credits are suggested for the MLS Knowledge and Skills digital badge, and 1 ECTS credit for each of the other three. For context, each single ECTS credit is equivalent to 25 learner effort hours.

In the interests of brevity, we choose not to discuss in detail here the content of each badge. We have included the details of the *Professional Identity Development* badge within Appendix B, but details for all badges, including the evidence required for competence, supporting sample workshop materials, etc., are available via the IMLSN website (IMLSN, 2022a). However, there are several important features to note. Whilst the competences that a tutor must demonstrate for each are common, they are grounded in the provision and practice of MLS. How they are developed and evidenced is afforded a degree of personalization to reflect not only the institution within which the tutor works, but also the local role that they have within MLS. To complete one of the four digital badges, a tutor must liaise with their local, typically institutional, MLS coordinator to explore how their current or planned duties within MLS satisfy the criteria for that competence, the training and development activities that they need to undertake and the evidence that needs to be collected, typically in the form of a portfolio, to demonstrate their successful completion.

This is a bespoke approach, but one that affords a number of benefits. It enables tutors to complete the work necessary to achieve a digital badge in a way that recognizes the nuances of their roles and any time constraints they might have. This is important because for many working as tutors within MLS, this is often as part of a wider role or study. It also ensures that tutors will be provided with a recognition for the learning achieved in a form, in this case a digital badge, that they can easily record for career purposes and disseminate quickly via professional social networks.

Critical to the successful delivery of this model of training provision is the MLS coordinator within an institution who is able to articulate the key needs of both the students accessing the MLS service and the tutors providing support. The training model therefore recognizes that the MLS coordinator is

best placed to oversee and validate the learning associated with each digital badge. However, this is an additional duty for staff members who are already busy, and so the administrative processes associated with the award of the digital badges needs to be streamlined, but with the necessary quality assurance checks in place to ensure the validity of the award.

The local MLS coordinator facilitates the necessary training and accepts and validates the evidence that a tutor submits to ensure that the learning outcomes associated with each module have been met. When the local MLS coordinator is satisfied that a tutor has demonstrated the completion of all learning outcomes associated with a competence, the information is sent to an IMLSN *MLS Tutor Competences Coordinator*. The IMLSN *MLS Tutor Competences Coordinator* is an experienced but independent MLS practitioner who verifies that all tasks have been completed and validates that the evidence submitted demonstrates full completion of the learning outcomes associated with the digital badge. They then issue the awarded digital badge directly to the tutor using only their email address.

To support the local MLS coordinator, extensive training and support materials have been compiled (IMLSN, 2022b). This includes evidence log templates to enable efficient and appropriate record keeping of the work that has been completed by the tutor, allowing for local variances and 'equivalent' tasks to be explicitly noted, evidenced and shared more widely through the national MLS networks.

4. Research Methodology

Following its development, the *Four Competences Model for MLS Tutor Training* was piloted within two institutions in Ireland, Maynooth University and the University of Galway, during the 2018–2019, 2019–2020, and 2020–2021 academic years. Of the 17 tutors who volunteered to participate in this trial, six were working either on an occasional or full-time basis within their institutional MLS centre and 11 were postgraduate tutors. Whilst all tutors were paid for their work in MLS, no additional payment was made for participating in the competency training and, therefore, no conflict of interest occurred. Eleven of the participating tutors responded to a short survey, which was issued in each institution at the end of each of the three academic years. Of these 11 tutors, five completed it twice, once at the end of 2019–2020, and again at the end of 2020–2021, as they completed different digital badges. Initially these data were collected and considered with a view to making adjustments, where necessary, to the training model. Subsequently, at both institutions, ethical approval was sought for the secondary use of this data and its analysis in publication. Ethical approval was granted, and all eleven tutors provided their consent for data they had supplied to be used in the research reported here. We now report on our analysis of this feedback and the feedback from the two MLS coordinators overseeing its implementation.

The survey consisted of four open-response questions:

1. What did you think of the programme?
2. How much time was involved?
3. Should we continue running it (which means having regular workshops with a variety of themes where badges can be earned)?
4. If so, how could it be improved?

The two MLS coordinators, who are also authors of this work, and who facilitated the training sessions at the institutions involved, provided their feedback on the different digital badge implementations. This was in the form of unstructured written reports completed independently and prior to the analysis we now report. They broadly explored logistical issues for the *IMLSN MLS Tutor Competences Coordinator*, observations on the experience of the tutors participating in the programme and wider practical comments

that would be of interest to other MLS coordinators in facilitating the implementation of the digital badges within their own institutions.

To explore the free-text responses of both the tutors and the local MLS coordinators, thematic analysis, as outlined in Braun & Clarke (2006), was used. Thematic analysis is a method for identifying patterns or themes within qualitative data that can then be used as basis for exploring a particular issue. It is not aligned with a particular epistemological or theoretical perspective and hence affords great flexibility when exploring qualitative data gathered from teaching and learning.

Braun & Clark (2006) provide a six-step process for identifying, analysing and reporting qualitative data using thematic analysis, and their methodology formed the foundation of the approach utilized here. It first involves the researcher(s) familiarizing themselves with their data; in this case the authors independently reading and re-reading the collected qualitative data, noting emerging or common ideas and then generating initial codes to identify the features of the data that appear interesting and meaningful. The next stage involved the authors searching for themes within the dataset based upon their own interpretation of the generated codes. Relevant data extracts that began to identify the relationship between the codes and themes were at this stage identified. The independently identified themes were then reviewed collectively by all authors to determine whether they should be refined, combined, separated or discarded to ensure there existed an identifiable distinction between each. Once the themes had been identified and agreed by all authors, they were named and defined, and the entire dataset re-reviewed to ensure the coded extracts collected by each researcher were relevant to those themes. Finally, the authors met to develop the analysis into an overall narrative, which is what we now report here.

In many forms of research into teaching and learning, the research is driven by a research question posed at the outset that then shapes the epistemology, theoretical perspectives, methodology and research methods used. Here, the research was not driven by a research question. Braun & Clarke (2006) make a distinction between a theoretical thematic analysis, that is, one whose direction is driven by the research question(s) itself or the perspective of the individual(s) undertaking the analysis, and an inductive approach, which is one that is driven by the data itself. Here, the latter approach was used.

For the purposes of coding, the tutors were assigned labels from T1 to T11. Similarly, the two coordinators were assigned the labels C1 and C2. When coding responses from these individuals, if the same tutor made similar comments across multiple surveys, they were counted only once.

5. Results

Overall, all 11 tutors were broadly positive about their participation in the pilot programme and the nine tutors who responded to the question regarding its continuation agreed that it should be continued. The results of the general thematic analysis are presented in Section 5.1, and we consider responses to the questions 'How much time was involved?' and 'How could the programme be improved?' in Section 5.2.

5.1 Thematic Analysis

Within the overall very positive feedback from participants, thematic analysis identified three clear and recurring features within the qualitative datasets. The first is the **importance of community;** the second, **developing as a professional;** and the third, **motivating and enabling professional development**.

5.1.1 Importance of Community. The **importance of community** theme, which encompasses the aspects of both collaboration and group work, emerged from tutor comments recognizing the benefits of

collaborating with fellow tutors and also the learning that takes place when they share their ideas and experiences with others. For example, '*I … enjoyed the workshop—it was informative, but it was especially good as a way to share experiences between tutors and to make me think about my teaching in a more constructive and critical way*' (T8). One tutor stated that they '*… find* [tutoring] *reviews very useful and formative … * [to establish] *what are the weakness*es *that* [they] *need to work on*' (T9).

This willingness of tutors to share their experiences was also noted by both the MLS coordinators and something that they chose to comment specifically upon within their reports. They remarked that tutors '*… appreciated that they were allowed to share their experiences* [of tutoring in] *the MSC*' (C1) and that '*There was a great buzz in the workshop. Tutors were confident to engage and talk about their experiences from the beginning on*' (C2).

The value placed by tutors on the collaborative aspects of the provision was further exemplified by the suggestions from several that increasing this aspect of the programme would be desirable. Several tutors, when discussing possible future enhancements to the programme, made observations centred around a desire for increased collaboration with their peers. For example, with regards to the *Communications/Dialogue Skill* digital badge, one stated that '*I would maybe suggest having more emphasis on having some group role play*' (T7). In a similar vein, another added that '*rather than a written report on a paper for the communications badge, have a presentation of the report. That would improve communication through presentation skills, and we can see what other people worked on*' (T2). This desire for an increased awareness of other tutor approaches, so that tutors can learn and develop their own teaching practices, is also evident in the suggestion for enhancement of the programme by another: '*Sharing the e-portfolios would be another way to see different techniques*' (T2). Similarly, another commented that '*running workshops with other tutors from different colleges and university* [sic] *could be interesting to get insights from different tutor experiences*' (T1).

5.1.2 Developing as a Professional. The **developing as a professional** theme contains three clearly evident sub-themes: **teaching skills**, **importance of reflection** and **gaining insights**.

The primary aim of this model is to facilitate the development of the **teaching skills** of tutors, and this was exemplified through the emergence of this theme in the tutor responses. As one observed, participation '*… refines the tutor's skills, which in return enable tutors to deal with different students' needs*' (T10). Some commented that, even though they may have already had several years of practice-based experience, they '*… gained some useful knowledge and skills*' (T7). Tutors also remarked how they both discovered, and were exposed to, ideas and technologies they may not otherwise have encountered, for example, '*The digital capacity badge I found to be useful in the current climate as not only did I learn about the digital media I was using but we also got reviews of other digital medias from the other tutors*' (T6). Several others further demonstrated their appreciation for this approach to supporting their learning as practitioners by expressing a desire to partake in other digital badges or by suggesting the expansion of the current suite of digital badges on offer.

Several of the tutors' comments acknowledge the **importance of reflection** and, in particular, the activity of compiling a reflective diary as a powerful tool for the development of their teaching skills: '*The task of keeping a reflective journal was interesting as while I usually reflect on my tutor sessions, putting it on paper resulted in a deeper analysis*' (T6). The ongoing nature of the reflective process was identified and highlighted by another: '*… it can be really useful to reflect on the way you are tutoring. The methods you are using and make sure you are constantly improving how you teach …*' (T11). The value of reflection was also cited by a respondent who stated they '*… found the reflective work such as the diaries and preparation accounts to be the most beneficial …*' (T4).

As part of the validation process for the award of the digital badges, the MLS coordinators reviewed the reflective accounts submitted by tutors as part of their evidence. They too commented on the tutors' growth as evidenced by their reflective journals. For example, '. . . *you could see in the early entries . . . they recorded some frustrations they had with things they maybe could have handled a bit better*' and '*It was nice to see in later entries . . . how they learned from those . . . experiences*' (C1).

The MLS coordinators reported that the process afforded an increased opportunity for **gaining insights** into the individual challenges experienced by tutors within their roles and the development of the views and perspectives that tutors hold towards MLS, teaching and learning, and also towards the students who participate in these activities. This was based upon observations during the developmental workshops that ran as part of the training programme and reviews of the submitted tutor materials. The coordinators explicitly noted that without this programme, these would likely have otherwise remained unknown. For example, the MLS coordinators observed that the group discussions provided an opportunity to hear about the problems and successes of the tutors in their day-to-day teaching: '*As the . . . tutors all have a lot of experience, they were encouraged to share their experiences and we had some great discussions on many topics that arose*' (C1). Furthermore, from the evidence submitted in fulfilment of the award of the digital badge, one coordinator remarked that tutor reflective diaries '. . . *proved to be useful resources for me as they provide insight into what the tutors learned from the workshop and what they find important to remember, and also to initiate conversation with individual tutors about their work*' (C2).

5.1.3 Motivating and Enabling Professional Development. The **motivating and enabling professional development** theme contains two evident sub-themes: **opportunity and recognition**, and **flexibility and variety**.

As we have noted previously in Section 3, a key factor in the establishment of this programme was the general lack of formal recognition available for the training that MLS tutors receive. It was therefore encouraging to find that the tutors were quite vocal in their appreciation of the **opportunity** to partake in a recognized continuing professional development programme and the visibility and **recognition** that this affords. They recognized that it is essential to stay abreast with the best practice and a structured programme, such as the one we describe here, is '. . . *a great way to incentivize extra-curricular activities (going to a conference, reviewing academic journals etc.)*' (T4). One tutor went further and commented on the limited options previously available to them for tutor training and how this addressed an identified gap: '*I think it was a great idea, it offers a great opportunity for some professional development within third level maths education, which is certainly lacking from a tutor's point of view*'. They added that, prior to the introduction of this pilot programme, there was an absence of formal recognition for any extra training they may have participated in: '*To get some sort of qualification or badge is extremely important for tutors as there are no other qualifications out there*' (T3).

The series of workshops that comprise each digital badge can be readily adapted to align with local (institutional) schemes for those new to tutoring or to address time-related or other delivery constraints. The **flexibility and variety** of both the workshop programme and the requirements for submission of evidence to demonstrate learning outcomes have been attained and is something that is also appreciated by tutors along with MLS coordinators.

Several tutors mentioned that they liked the range of tasks: '*The variety of requirements was great. Initially I thought it would only be based on workshops*' (T4). Other tutors also expressed that they '. . . *appreciate*[d] *the flexibility . . . given when completing the tasks*' but struggled '. . . *to complete the tasks in a reasonable time*' (T5). The same tutor also suggested that they would '*benefit from each of the tasks having deadlines*' to help provide some further structure to the learning process and provide a focus for

submission of the individual evidence. The MLS coordinators remarked on the adaptability of the badges '*. . . to make the content more appropriate for the ... [local] environment . . . and to take into account that the tutors taking this badge had, in most cases, a lot of ... teaching experience*' (C1). One MLS coordinator acknowledged that the package of the four digital badges into an overall award facilitates the organization of workshops in a way that all tutors are motivated to participate to some degree. For example: '*inviting new tutors only to the first session of a half-day workshop and leaving the remaining sessions open for all, worked well for us and we will continue this approach*' (C2). The coordinators also commented on how the freedom to run the badges at suitable times afforded flexibility to support and facilitate tutor engagement: '*Going forward, I would spread the workshop over two semesters, and schedule a shorter workshop for the middle of semester 2*' (C2).

Another aspect afforded by the flexibility of the programme, as highlighted by the coordinators, is that it provides natural opportunities for collaboration with a variety of local student or staff support services. For example, when the training workshops were conducted at one of the institutions, there was input from the unit that supports the pedagogical and professional development of members of staff. The coordinator observed that: '*Colleagues from CELT* [Centre for Excellence in Learning and Teaching] *have provided very beneficial support to this project, and I am currently discussing potential for more cooperation on this*' (C2).

5.2   *Evaluation of Implementation*

One of the four questions posed to tutors asked them to explicitly consider the time commitment involved. The majority of tutors reported that the time required to complete the tasks was reasonable. For example, '*Given that I was working* [tutoring] *at the time doing the project, I found the time involved is very manageable*' (T7). However, one tutor commented on the challenge of completing more than one badge simultaneously, which participants were allowed to do during the pilot phase: '*The amount of time required was more than I initially expected. That may have come down to the fact that we did . . .* [two] *badges close together. This meant there was a number of objectives required at the same time which felt a bit intimidating*' (T4).

The coordinators also commented on the time commitment from their perspective. For example, they mentioned that it can be problematic to find a time when everyone is available to meet for workshops. Furthermore, while they remarked that '*Coordinating, writing, and delivering the workshop was the most work*' (C1), they added that '*Existing material created by the IMLSN proved to be helpful as an initial starting point*' (C2). For any given workshop, the preparation required varying levels of MLS coordinator input depending on local MLS circumstances in the institution. The coordinators also observed that '*It took some time and several reminders to collect all required documents from the badge earners*' and to review the submitted material, although '*updating the evidence log and awarding the badges was relatively quick*' (C1).

Another question posed to the tutors sought to explore how participants felt the programme might be improved in the future recognizing that the activities formed an initial pilot. In addition to the request for further badges, mentioned above, tutors also referred to differentiated badge content. For example, '*Maybe alter the material being taught depending on if people are an experienced tutor or a new tutor*' (T1). This was echoed by one coordinator who noticed an inconsistency between '*the level of experience the tutors have*' and '*. . . the somewhat introductory material in workshop 1* [Knowledge and Skills]' (C1). Similarly, several other tutors considered how the programme might be further developed, through the addition of new workshops and/or learning outcomes, to offer additional opportunities to enhance their teaching skills. For example, '*Maybe a workshop on how to deal with difficult situations that can*

occur while working in MLS. Then have a section of the workshop focusing on one tutor playing the role of an upset student while another tutor tries to deal with the situation' (T7). In other responses, the importance of this development taking place with support from others was also emphasized, '*I find reviews (either from peers as well as from lecturers/professors) very useful and formative. It would be great for me to have more of such experience to better focus on what are the weakness that I need to work on*' (T9).

6. Discussion

Although not established as a research study, the use of thematic analysis to analyse the written free-text accounts of those who participated in this pilot programme to better recognize the training that MLS tutors receive has enabled the identification of a series of common themes. Collectively, the themes demonstrate how tutors not only recognize their own personal and professional development, but also how participating in the pilot programme has enabled their development to take place. Tutors reported having '*very insightful*' (T1) experiences, and that the content was engaging and '*clearly beneficial for a new tutor just starting out but … still great for tutors who have more years of experience*' (T5). Following their participation in the programme, tutors also reported increased ownership of their role and of its importance within the overall student academic support framework within their institutions. As one tutor stated, '*It's given me more confidence, I feel invested in the success of the MSC* [Mathematics Support Centre] *and the experience of the students*' (T5). Further, by exploring how the programme might be enhanced in future iterations of its delivery, individuals are also recognizing areas where additional developmental activities would benefit themselves and others who work in MLS.

We have found that tutors demonstrate a desire to learn from, and then contribute to, the professional development of their peers. This is something Grove & Croft (2019, p. 261) also identified with '*tutors attach*[ing] *value to participating in a community with other tutors and draw extensively upon their expertise*'. The tutors involved in their study had different levels of experience in working in mathematics support. Those with more experience ('*the old-timers*') were willing to share this with ('*the newcomers*'). Furthermore, we have found that MLS tutors acknowledge their self-development through participating in a structured training programme. This corresponds with Walsh (2017), who advised that tutor training should include '*a practical element where tutors can practice teaching mathematics and receive feedback on their large group classroom teaching from an experienced educator*'.

Tutors recognized and appreciated the flexibility and variety within the pilot training programme. At one level, this might be seen as facilitating their engagement with the requirements of the programme based around their other commitments. This is important because the tutors in this programme also had other roles, either as postgraduate research students, or other institutional teaching and support duties. Additionally, the flexibility and variety allows them to undertake training and development in areas most relevant to their roles and their identified development needs.

As Mann *et al.* (2009, p. 595) report, the importance of reflection and reflective practice are frequently noted in the general education literature, and '*reflective capacity is regarded by many as an essential characteristic for professional competence*'. Although their work considers the education of healthcare professions, its importance to practice-based programmes focused upon teaching and learning is explicitly highlighted within the UK Professional Standards Framework, which seeks to foster '*reflective and evidence-informed approaches to teaching and/or supporting learning*' (UK Professional Standards Framework, 2023, p. 2).

Similarly, the importance of reflection in improving teaching is well documented and has become an important part of teacher education programmes. Harford and MacRuaric (2008, p. 1890), when

considering how to promote meaningful reflection amongst student teachers, found that working in the context of a community of practice aided the development of reflective skills; meanwhile Slade *et al.* (2019, p. 8), again when considering student teachers, noted '*the positive impact of reflective practice on student learning as indicated by acquisition of educational knowledge, skills and dispositions*'.

In essence, reflection is not only a skill that allows those working in education to develop a wider awareness of their practice, but also a means by which to inform and enhance that professional practice. By explicitly considering suggestions for improvements, tutors demonstrate a level of reflection upon their overall experience of participating in the pilot programme. Significantly, their observations also demonstrate the importance of being part of a community of practitioners, in the context of the desire to enhance future iterations of the programme for other participants. For example, one tutor commented that '*A review session where people present their work would be a good chance to learn from each other*' (T2), demonstrating the value they place upon working and learning from others. Another tutor indicated that previous participants have a role in supporting and encouraging engagement by those who are new to tutoring and in contributing to the ongoing development of the community, '*During the normal tutor training next year, one of the tutors who did the badges this year could help share their experience to encourage new tutors to do them too*' (T5).

The *Four Competences Model for MLS Tutor Training* is underpinned by the three aims and six features that were discussed in Section 3.2. We observe that the feedback gathered during this pilot activity programme offers evidence that all have been successfully achieved via its implementation. Through the subsequent analysis undertaken, we have seen that by providing a range of development opportunities, tutors have been encouraged to engage with comments specifically valuing the variety and flexibility of the activities [Aim 2] in a manner that allows them to balance these with individual time commitments and constraints [Feature b]. This flexibility was also echoed by the two local coordinators who oversaw the implementation of the scheme within their institutions. They recognized the opportunities that local tailoring [Feature c] afforded to facilitate engagement with other institutional groupings, along with how, by building upon existing disciplinary resources and practices [Feature e], this helped minimize the administrative burden upon them [Feature f]. The benefits of engaging with a practitioner community also formed a theme identified amongst tutors through the thematic analysis.

The developed pilot programme was aligned with the *Irish National Professional Development Framework for All Staff Who Teach in Higher Education* [Feature a]. This, coupled with the digital badge initiative of the *National Forum for the Enhancement of Teaching and Learning in Higher Education* allowed immediate recognition [Feature d] of learning that tutors could record for career purposes and share with others via personal networks [Aim 3]. Indeed, opportunity and recognition were themes that also emerged from the thematic analysis and formed the primary motivation for the development of the *Four Competences Model for MLS Tutor Training* at its outset.

Although a training programme was provided based upon the specific nature of the roles undertaken by tutors working in MLS [Aim 1], its impact upon the learning experience of the student users of MLS within the institutions was not completed in the available time frame of this work. There does though exist evidence, emerging from the themes of reflection and suggestions for improvements, that tutors have developed their practice through participating in the programme in a manner that will offer wider benefits to the student learning experience. Further, the activities of the programme were grounded in known good practice in training tutors to work in MLS (Croft & Grove, 2012) and embedding the known features, as identified by students themselves, of what tutors should and should not do, when working in MLS (Fitzmaurice & Mac an Bhaird, 2021).

7. Conclusions

For MLS tutor training, at least in the UK and Ireland, Grove & Croft (2019, p. 261) recommended that an initial 1-day training session should be '*supplemented by an ongoing set of regular continuing professional development opportunities in recognition of the fact that most learning is situated in practice*'. In our work, we have demonstrated that a structured and recognized developmental programme, enabled by a national MLS network, can help tutors develop their professional practice through their provision of MLS.

This work also provides insight into the features that are likely to be key to embedding a successful disciplinary-based training programme. The themes and sub-themes of '**importance of community**', '**teaching skills**', '**importance of reflection**', '**opportunity and recognition**' and '**flexibility and variety**' all emerged prominently from our thematic analysis and therefore form features that those developing such training should consider, along with the need to ensure a programme that is time-efficient for both participants and coordinators. Through the development and review of the pilot implementation of the *Four Competences Model for MLS Tutor Training*, we have identified a non-exhaustive nine-point checklist of qualities to consider when developing similar professional development provision and which we believe may be helpful for those wishing to embed practitioner-led forms of training within their own disciplines, see Appendix C.

At a local level, the tutors really appreciated the formal recognition that this model of tutor training provides, and we are currently working on getting the completed badges and their associated ECTS recognized by our institutions. Our findings confirm that these four badges provide a solid foundation for MLS tutor training. It should be noted that this training programme provides tutors with a professional development opportunity structured to ground their ongoing teaching development given that the training is strategically aligned with an established national framework (NF, 2016). The model structure also facilitates the possibility of further complementary badges, for example, in relation to accessibility, which is currently being investigated in response to increasingly diverse student needs, but also poses questions that will need further consideration if such an approach is to develop at scale.

The delivery of the pilot programme described here has not only been enabled by being grounded within an active national network of MLS practitioners, but has relied upon the presence of an experienced, but independent, MLS practitioner to assume the role IMLSN *MLS Tutor Competences Coordinator*. This role is essential in validating the tutor awards but is entirely voluntary. To extend the model beyond two pilot institutions, further consideration needs to be given to resourcing. Similarly, whilst this current pilot, since it involved tutors with academic backgrounds in the mathematical sciences, did not seek to support the development of subject-specific knowledge, further consideration needs to be given as to how non-specialist tutors might also be supported in enhancing student learning of mathematics. It would also be interesting to compare our model with the training used in other countries, for example, in the USA, where tutor training is highly valued by MLS coordinators (Mills *et al.*, 2020) and where there is considerable use of non-PhD tutors (Mac an Bhaird & Thomas, 2023).

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

AHMED, S., DAVIDSON, P., DURKACZ, K., MACDONALD, C. & RICHARD, M. (2018) The provision of mathematics and statistics support in Scottish higher education institutions (2017) – a comparative study of the Scottish Mathematics Support Network. *MSOR Connect.*, **16**, 5–19.

BRAUN, V. & CLARKE, V. (2006) Using thematic analysis in psychology. *Qual. Res. Psychol.*, **3**, 77–101.

CROFT, A. C. & GROVE, M. J. (2012) *Tutoring in a Mathematics Support Centre: a Guide for Postgraduate Students.* Birmingham, UK: National HE STEM Programme. http://www.sigma-network.ac.uk/wp-content/uploads/2012/11/46836-Tutoring-in-MSC-Web.pdf (19 November 2022, Date accessed).

CROFT, A. C., GROVE, M. & LAWSON, D. (2022) The importance of mathematics and statistics support in English universities: an analysis of institutionally-written regulatory documents. *J. High. Educ. Policy Manag.*, **44**, 240–257.

CRONIN, A., COLE, J., CLANCY, M., BREEN, C. & Ó'SÉ, D. (2016) An audit of mathematics learning support provision on the Island of Ireland in 2015. *An Irish Mathematics Learning Support Network Report* (J. COLE, A. CRONIN, C. O'SULLIVAN & C. MAC AN BHAIRD eds). http://www.imlsn.ie/images/Documents/IMLSN_Report_2015.pdf (19 November 2022, Date accessed).

DONNELLY, R. & MAGUIRE, T. (2020) Establishing and sustaining national partnerships in professional development and the recognition of open courses in teaching and learning through digital badges. *Australas. J. Educ. Technol.*, **36**, 1–17.

FITZMAURICE, O. & MAC AN BHAIRD, C. (2021) Effective tutoring in mathematics learning support: the student perspective. *Int. J. Math. Educ. Sci. Technol.*, **54**, 416–432.

GROVE, M. J. & CROFT, A. C. (2019) Learning to be a postgraduate tutor in a mathematics support centre. *Int. J. Res. Under. Math. Educ.*, **5**, 228–266.

GROVE, M. J., MAC AN BHAIRD, C. & O'SULLIVAN, C. (2019) Professional development opportunities for tutors of mathematics learning support. *MSOR Connect.*, **18**, 4–15.

GROVE, M. J., CROFT, T. & LAWSON, D. (2020a) The extent and uptake of mathematics support in higher education: results from the 2018 survey. *Teach. Math. Appl.*, **39**, 86–104.

GROVE, M. J., GUIRY, S. & CROFT, A. C. (2020b) Specialist and more-able mathematics students: understanding their engagement with mathematics support. *Int. J. Math. Educ. Sci. Technol.*, **51**, 643–668.

HARFORD, J. & MACRUAIRC, G. (2008) Engaging student teachers in meaningful reflective practice. *Teach. Teach. Educ.*, **24**, 1884–1892.

HAWKES, T. & SAVAGE, M. D. (2000) *Measuring the Mathematics Problem.* London, UK:Engineering Council. http://www.engc.org.uk/engcdocuments/internet/Website/Measuring%20the%20Mathematic%20Problems.pdf (19 November 2022, Date accessed).

IMLSN. (2022a) Mathematics learning support tutor competences. https://www.imlsn.ie/index.php/tutor-development (19 November 2022, Date accessed).

IMLSN. (2022b) Role of the local MLS coordinator in the Mathematics Learning Support Tutor 4 Competences training model. http://www.imlsn.ie/index.php/tutor-development/14-tutor-development/20-role-of-the-local-mls-coordinator-in-the-mathematics-learning-support-tutor-4-competences-training-model (19 November 2022, Date accessed).

LAWSON, D., CROFT, A. & HALPIN, M. (2003) *Good Practice in the Provision of Mathematics Support Centres* (2nd ed.). Birmingham, UK: LTSN Maths, Stats & OR Network. http://www.mathcentre.ac.uk/resources/guides/goodpractice2E.pdf (19 November 2022, Date accessed).

LAWSON, D., GROVE, M. J. & CROFT, T. (2020) The evolution of mathematics support: a literature review. *Int. J. Math. Educ. Sci. Technol.*, **51**, 1224–1254.

LMS, IMA & RSS (1995) *Tackling the Mathematics Problem* A joint report of The London Mathematical Society, The Institute of Mathematics and its applications and The Royal Statistical Society. London, UK: The London Mathematical Society.

MAC AN BHAIRD, C. & THOMAS, D. A. (2023) A survey of Mathematics Learning Support in the United States. *Teach. Math. Appl.*, **42**, 249–265.

MACGILLIVRAY, H. (2009) Learning support in mathematics and statistics in Australian universities – a guide for the university sector. *Australian Learning and Teaching Council.* https://www.mathcentre.ac.uk/resources/uploaded/guide--altc-learning-support-in-maths-and-stats.pdf (19 November 2022, Date accessed).

MANN, K., GORDON, J. & MACLEOD, A. (2009) Reflection and reflective practice in health professions education: a systematic review. *Adv. Health Sci. Educ. Theory Pract.*, **14**, 595–621.

MARR, C. M. & GROVE, M. J. (eds.) (2010) *Responding to the Mathematics Problem.* The Implementation of Institutional Support Mechanisms. Birmingham, UK: Maths, Stats & OR Network. http://www.mathcentre.ac.uk/resources/uploaded/mathssupportvolumefinal.pdf (19 November 2022, Date accessed).

MATTHEWS, J., CROFT, A. C., LAWSON, D. A. & WALLER, D. (2013) Evaluation of mathematics support centres: a literature review. *Teach. Math. Appl.*, **32**, 173–190.

MILLS, M., RICKARD, B. & GUEST, B. (2020) Survey of mathematics tutoring centres in the USA. *Int. J. Math. Educ. Sci. Technol.*, **53**, 948–968.

NATIONAL FORUM. (2016) *National Professional Development Framework for all Staff who Teach in Higher Education*. Dublin, Ireland: National Forum for the Enhancement of Teaching and Learning in Higher Education. http://www.teachingandlearning.ie/wp-content/uploads/2016/09/PD-Framework-FINAL-1.pdf. (19 November 2022, Date accessed).

NATIONAL FORUM. (2021a). *Open Courses – Recognising Professional Development*. https://opencourses.ie (accessed 19 November 2022).

NATIONAL FORUM. (2021b). *Mathematics Learning Support: Tutor Development*. https://opencourses.ie/opencourse/mathematics-learning-support-tutor-development/ (19 November 2022, Date accessed).

O'NEILL, G., MAGUIRE, T. & NOONAN, E. (2016) Developing an Irish professional development framework for teaching and learning. *The Changing Higher Education Learning Environment. European Distance and E-Learning Network (EDEN) Conference Proceedings*, pp. 622–632. https://www.ceeol.com/search/article-detail?id=846781 (28 February 2023, Date accessed).

O'SULLIVAN, C., MAC AN BHAIRD, C., FITZMAURICE, O. & NÍ FHLOINN, E. (2014) *An Irish Mathematics Learning Support Network (IMLSN) Report on Student Evaluation of Mathematics Learning Support: Insights from a Large Scale Multi-institutional Survey*. Limerick, Ireland: NCE-MSTL. http://www.sigma-network.ac.uk/wp-content/uploads/2019/02/IMLSN-Report-Student-evaluation-of-MLS-2016.pdf (19 November 2022, Date accessed).

PFEIFFER, K., CRONIN, A. & MAC AN BHAIRD, C. (2016) The key role of tutors in mathematics learning support – a report of the 10th annual IMLSN workshop. *MSOR Connect.*, **15**, 39–46.

SCHÜRMANN, M., GILDEHAUS, L., LIEBENDÖRFER, M., SCHAPER, N., BIEHLER, R., HOCHMUTH, R., KUKLINSKI, C. & LANKEIT, E. (2020) Mathematics learning support centres in Germany—an overview. *Teach. Math. Appl.*, **40**, 99–113.

SLADE, M. L., BURNHAM, T. J., CATALANA, S. M. & WATERS, T. (2019) The impact of reflective practice on teacher candidates' learning. *Int. J. Scholarship Teach. Learn.*, **13**, article 15. https://doi.org/10.20429/ijsotl.2019.130215.

SUTHERLAND, R. & POZZI, S. (1995) *The Changing Mathematical Background of Undergraduate Engineers*. London, UK: The Engineering Council.

UK PROFESSIONAL STANDARDS FRAMEWORK. (2011) *The UK Professional Standards Framework for Teaching and Supporting Learning in Higher Education.* https://www.advance-he.ac.uk/knowledge-hub/uk-professional-standards-framework-ukpsf (19 November 2022, Date accessed).

UK PROFESSIONAL STANDARDS FRAMEWORK. (2023) *Professional Standards Framework for Teaching and Supporting Learning in Higher Education 2023.* https://advance-he.ac.uk/knowledge-hub/professional-standards-framework-teaching-and-supporting-learning-higher-education-0?_ga=2.85759262.663199911.1685095511-960711320.1684907317 (26 May 2023, Date accessed).

WALSH, R. (2017) A case study of pedagogy of mathematics support tutors without a background in mathematics education. *Int. J. Math. Educ. Sci. Technol.*, **48**, 67–82.

Appendix A

The high-level mapping to the three areas of the UK Professional Standards Framework (2011) and the individual descriptors within each.

MLS badge	UK Professional Standards Framework
	Core Knowledge
Knowledge and Skills	K1 The subject material.
Knowledge and Skills	K2 Appropriate methods for teaching, learning, and assessing in the subject area and at the level of the academic programme.
Knowledge and Skills	K3 How students learn, both generally and within their subject/disciplinary area(s).
Digital Capacity	K4 The use and value of appropriate learning technologies.
Professional Identity Development	K5 Methods for evaluating the effectiveness of teaching.
Professional Identity Development	K6 The implications of quality assurance and quality enhancement for academic and professional practice with a particular focus on teaching.
	Professional Values
Knowledge and Skills	V1 Respect individual learners and diverse learning communities.
Knowledge and Skills	V2 Promote participation in higher education and equality of opportunity for learners.
Communication/Dialogue	V3 Use evidence-informed approaches and the outcomes from research, scholarship and continuing professional development.
Professional Identity Development	V4 Acknowledge the wider context in which higher education operates recognising the implications for professional practice.
	Areas of Activity
Knowledge and Skills	A1 Design and plan learning activities and/or programmes of study.
Knowledge and Skills	A2 Teach and/or support learning.
Communication/Dialogue	A3 Assess and give feedback to learners.
Digital Capacity	A4 Develop effective learning environments and approaches to student support and guidance.
Communication/Dialogue	A5 Engage in continuing professional development in subjects/disciplines and their pedagogy, incorporating research, scholarship, and the evaluation of professional practices.

Appendix B

This appendix contains the Description and Criteria aspects of the Professional Identity Development digital badge. There is a Description section that gives an overview of the purpose of the badge. The last section is entitled Criteria. This section states in two connected lists what the tutor is expected to be able to do as a result of the learning associated with this competence and what the tutor has done to demonstrate that this learning has been achieved. To access complete details of all the badges, see IMLSN—Tutor Development (IMLSN, 2022a).

Description:	The purpose of this digital badge is to establish a framework of knowledge and techniques to enable tutors to develop in their future work in Mathematics Learning Support (MLS).
Criteria:	***The owner of this digital badge is able to:*** • Identify how their prior learning experiences can contribute to or be barriers to their provision of MLS. • Identify the positive impact that MLS can have on students. • Assimilate the insights of experienced tutors of MLS into their practice. • Use techniques of reflection on key competencies to improve their skills as an MLS tutor on an ongoing basis. ***The owner of this digital badge has demonstrated these abilities by doing the following (or equivalent):*** • Completing a workshop on professional development in MLS and maintaining a reflective diary over 6 weeks/sessions. • Writing a short essay on their top 3 do's/don'ts on working in MLS. • Providing evidence that their MLS tutoring has been observed and evaluated by competent professionals or peers.

Appendix C

We include here a 9-point checklist of features which emerged from the development and review of the *Four Competences Model for MLS Tutor Training* pilot. We present them here in the hope that they might be helpful to others considering the development of similar schemes in the future.

1. Ensure the developed training programme meets the needs of those delivering the teaching duties in a way that brings enhancement to the student learning experience.
2. Provide a range of development opportunities that allow participants to see the relevance and benefits for their practice and future careers.
3. Afford participants opportunities to engage in a way that respect and support their individual circumstances and the time constraints of their roles.
4. Align with professional development frameworks and guidelines to allow for transferable recognition of the developed training.
5. Draw upon the knowledge, experience, and resources of the relevant disciplinary community to ground training in recognised disciplinary teaching practice.
6. Allow institutions to tailor the activities to ensure better alignment with the specific duties undertaken by those involved in teaching and the disciplinary/institutional nature of their roles.
7. Provide a mechanism for recognising and celebrating successful individual participation through local, national, and disciplinary networks.
8. Embed mechanisms for allowing participants to evidence their learning and development in a way that allows for institutional and/or professional accreditation.
9. Ensure the delivery of a programme that focuses upon the natural development and evidencing of practice development in a way that minimises the administrative burden upon those co-ordinating or leading the scheme.

Ciaran O'Sullivan has 38 years of experience as a mathematics educator and has been lecturing mathematics in TU Dublin since 1998. He has served as chairperson and vice-chairperson of the Irish Mathematics Learning Support Network (IMSLN). In 2015 he was awarded a National Teaching Expert Award in recognition of his contribution to mathematics teaching and learning excellence.

Michael Grove is Professor of Mathematics and Mathematics Education and Deputy Head within the School of Mathematics at the University of Birmingham. He is a National Teaching Fellow and was Associate Director of the Sigma Network for Mathematics and Statistics Support between 2013 and 2016. https://orcid.org/0000-0002-3150-125X.

Ciarán Mac an Bhaird is an Associate Professor in the Department of Mathematics and Statistics at Maynooth University, and he was Director of the Mathematics Support Centre until 2023. He has received multiple awards in recognition of his teaching and support of students. He was a founding committee member of the Irish Mathematics Learning Support Network and was appointed chair in 2022. His research focuses on mathematics education, the history of mathematics and occasionally algebraic number theory. https://orcid.org/0000-0001-5971-7709.

Peter Mulligan received his Master's degree in Mathematics from Maynooth University in 2006 and is also a fully qualified secondary school teacher, obtaining a Master's degree in Education from DCU in 2013. He has been tutoring in the Mathematics Support Centre in Maynooth since 2010 and is a member of the IMLSN committee since 2017. He is one of the inaugural winners of the 2021 Sigma Excellence in Tutoring Award. He also conducts research in mathematics education.

Kirsten Pfeiffer is a lecturer of mathematics and the manager of the Mathematics and Statistics Support Centre SUMS at the University of Galway. She has served as chairperson and vice-chairperson of the Irish Mathematics Learning Support Network (IMSLN). Her research focuses on the teaching and learning of mathematics at university level, with a special interest in the teaching of mathematical proof and the role of mathematics support centres from a sociocultural point of view.