# CASE STUDY

# The Pilot Maths Centre at the North West Regional College

Terence McIvor, Science and Mathematics, North West Regional College, Derry-Londonderry, Northern Ireland. Email: terence.mcivor@nwrc.ac.uk
Jonathan Cole, School of Mechanical and Aerospace Engineering, Queen's University Belfast, Belfast, Northern Ireland. Email: J.Cole@qub.ac.uk
Ciarán Mac an Bhaird, Department of Mathematics and Statistics, Maynooth University, Maynooth, Republic of Ireland. Email: ciaran.macanbhaird@nuim.ie

## Abstract

This paper discusses the establishment in 2015 of the first Maths Centre in any Further and Higher Education College in Northern Ireland. In particular, it considers the rationale for its development, how it was set up and how it runs. It also presents initial figures and feedback, and plans for future developments.

**Keywords:** Mathematics, Maths Centre, Further Education, Higher Education.

## 1. Background

North West Regional College (NWRC) is a leading provider of Further Education (FE), Higher Education (HE) and skills training in Northern Ireland. The three main campuses in Derry-Londonderry, Limavady, and Strabane boast modern and industry-standard learning environments at which over 20,000 students learn and train on professional equipment using professional codes of conduct to achieve their personal educational goals through full and part-time study every year.

NWRC has seven academic schools:

- Business Services and General Education;
- Science and Technology;
- Media, Multi Media and The Arts;
- Craft Services;
- Early Years Childcare, Hairdressing and Beauty Therapy;
- Health and Social Care;
- Hospitality, Tourism and Sport.

The student population ranges from school leavers and mature students, to professionals and jobseekers, who wish to improve their skills and qualifications. Students originate from all parts of Northern Ireland and the Republic of Ireland. In recent years, NWRC has witnessed an increase in student numbers across its Level 2 Diplomas (equivalent to GCSE), Level 3 Extended Diplomas (equivalent to A-level) and HE provision.

Routes into employment include the Level 2 Diploma and Level 3 Extended Diploma options which blend classroom delivery with real-life work-based challenges. For those wishing to progress to university, these programmes provide direct access into honours options both locally and throughout the UK. NWRC's part-time portfolio continues to grow and includes hundreds of courses in areas such as Essential Skills (Numeracy & Literacy), hobby and recreation, return to study and professional development, as well as the traditional part-time vocational courses.

NWRC is one of the largest employers in the North West as well as an education and training provider. It is a lead partner in the local Workforce Development Forum, partnering representatives of industry and commerce and the local council, to provide and develop a comprehensive range of

retraining programmes to suit the needs of local employers. NWRC works in partnership with local businesses, organisations universities and awarding bodies to develop and deliver bespoke training that will meet their individual requirements.

For some time, there has been research which assesses the provision of mathematics in primary and post-primary schools in order to establish the contribution made to the supply of people with science, technology, engineering and mathematics, e.g. the 'Set for Success' report from 2002 (Roberts, 2002). This report covered biological sciences, engineering, computer sciences, etc., in order to make recommendations on changes to the curriculum, qualifications and pedagogy for those aged 14 and over in schools, colleges and HE institutions. The aim was to give students the opportunity to acquire the mathematical knowledge and skills necessary to meet the requirements of employers and FE and HE.  The key findings suggested that there was a shortage of specialist maths teachers and that, in general, maths teachers were not adequately supported and nurtured due to the lack of resources, infrastructure and culture of continuing development.

A review of mathematics and in particular GCSE Mathematics describes, that even though the proportion of young people achieving good grades has gone up in recent years, employers, universities and colleges are often dissatisfied with school leavers' literacy and numeracy with around 42% of employers needing to organize additional training for young people joining them from school or college. The policy paper also states that "*We believe making GCSEs and A levels more rigorous will prepare students properly for life after school. It is also necessary to introduce a curriculum that gives individual schools and teachers greater freedom to teach in the way they know works and that ensures that all pupils acquire a core of essential knowledge in English, mathematics and sciences*". (GOV.UK, 2015).

More recently, the above review, including a public consultation, resulted in the announcement by the Education Secretary in early 2013 of proposals for a comprehensive reform of GCSEs. The implementation of such reform is effective from 2016. The resulting review means that all students will have to master the basics of mathematics, with greater provision for concepts such as ratio, proportion and rates of change. The 'new GCSE' will set higher expectations, demanding more from all students and making it more challenging for those aiming to achieve top grades. The broader aims of the review will see students more prepared for life after school, ensuring that all pupils acquire a core of essential knowledge in English, mathematics and sciences. Hancock stated that:

- 40% of pupils do not get GCSE grades A* to C in English and Mathematics by age 16;
- 90% of those who don't reach this basic standard by 16 don't achieve it by 19;
- From August 2014, students who have not achieved a good pass in English and/or Mathematics GCSE by age 16 must continue to work towards achieving these qualifications or an approved interim qualification as a 'stepping stone' towards GCSE as a condition of student places being funded;
- From September 2015, the reformed GCSE Mathematics and English will begin being taught in schools with the first examinations being sat in the Summer of 2017;
- Between 2015 and 2020, these new GCSEs will be introduced into post-16 education in phases;
- Necessary 'stepping stones', for example functional skills qualifications, will be made available to support students on the path to GCSE (Hancock, 2014).

The NWRC has an obligation to make the importance of mathematics more clearly and visibly recognised in addition to ensuring the potential contributions of mathematics to the economy and society are appreciated. More importantly, it must create the necessary provision to ensure students facing difficulties within STEM subjects or courses as a result of underlying weaknesses

in mathematics can get tutoring as a form of intervention to avoid failing/withdrawing from the subject or course (Cox, 2003). Furthermore, Maths is a core module in STEM courses, therefore the knowledge and application of it needs to be developed, particularly since staff had noticed that student skills gap in mathematics needed to be addressed to meet the expectations of FE and HE. Considering all of these factors, the College Board of Governors made the implementation of the Maths Centre (called 'The Cube') a requirement. We consulted with Joe English in Letterkenny Institute of Technology (LYIT) on best practice guidance (LYIT already has a Maths Centre on site) and we also reviewed existing advice documents, for example **sigma** (2015).

The Maths Centre was subsequently created to:

- give students the opportunity to improve their mathematical skills;
- develop student awareness of the applied nature of mathematics;
- gather information about the student cohort, enabling Curriculum Managers and or Heads of School to assess the changing nature of the student intake;
- provide teaching staff with information about gaps in the prior knowledge of the student group;
- identify particularly weak students within the group;
- provide key information for the acquisition of support materials within the Maths Centre.

Though this is the first Maths Centre in FE in Northern Ireland, maths support has been provided in some other FE colleges previously through different methods.

## 2. How the Maths Centre operates

The Maths Centre is situated in the Learning Resource area of the College. It is open 9a.m. – 7p.m. Monday to Thursday and 10a.m. - 4p.m. on Fridays, and is managed by the Curriculum Manager for Science and Mathematics. All students studying on the STEM programmes (Science, Engineering, Construction and IT) can access the Maths Centre. Currently, the service provided includes:

- one to one tutoring sessions centred on a learning plan determined by the result of a diagnostic test.
- small group tutoring sessions either recommended by a course tutor or by the students themselves.
- algebra workshops or workshops on additional topics identified as needed.

Diagnostic testing takes place at induction across campus. The test is currently paper based, however it will be electronic from September 2016 and students will have to complete the test as part of NWRC's online registration process. It is compulsory for STEM students. The test consists of 20 GCSE Maths style multiple choice questions. The results are sent directly to the Maths Centre tutors; if they identify significant skills gaps, then they refer the student to the service. The use of diagnostic testing to promote or encourage student use of extra mathematics support is a well-established approach and there is evidence that suggests students can respond well to such tests and prompts (Ní Fhloinn et al., 2014).

To access the Maths Centre provision, a student is either referred by a tutor following diagnostic testing or self-referral, and a learning plan is developed at the initial meeting. Further details on each form of referral are provided below:

Tutor Referral:

- After diagnostic testing is complete, students with significant gaps in their mathematical knowledge are referred to the Maths Centre.
- At mid-semester student review, tutors are encouraged to direct any student who they identify as struggling with maths-related course content to attend the Maths Centre.
- Tutors within the Maths Centre develop a personalised plan to address the identified gaps in student knowledge.

Self-Referral:

- Students who score well in the diagnostic test but do not completely understand all of the topics and concepts are able to self-refer.
- Self-referral involves filling out a referral form which would then be sent to the Student Support Centre and an induction tutoring session arranged. The Student Support Centre provides support for learning needs and can direct students to the Maths Centre for tutoring.

A set of guidelines was developed by **sigma** (Network for Excellence in Mathematics and Statistics Support) which would establish the qualities expected of a tutor/mentor in the Maths Centre (**sigma**, 2011). The guidelines were distributed to NWRC staff as part of a staff development plan. The tutors are all staff members and subject specialists and all very experienced in the tutoring of mathematics; they also teach mainstream programmes including maths modules (Access, Level 3 Diplomas and Foundation Degrees).

Tutors are expected to create and deliver bespoke lesson plans which identify areas to be covered that address a student's difficulties within mathematics within their vocational area. They will inform the student of how the sessions will be structured, identifying clear session by session objectives and completing a work record for each session allowing for student feedback as appropriate. A typical session can run from thirty minutes to an hour, depending on the level of support needed. Tutors should encourage each student to take an active approach to their learning and to developing problem solving skills. Staff are also expected to establish the best method of communication for the time/location of a tutoring session and be consistent in dealing with situations where students are late or absent. They should be familiar with Learning Support protocols in the event that an underlying problem is identified and promote additional learning support as a strategy to enhance effective learning. NWRC welcomes students with a variety of abilities and specialist support is available for students with physical and learning disabilities, e.g. dyslexia, visual impairment, mental health or mobility difficulties. Tutors also need to review student progress and provide completed worksheets reflecting the progress made and they should encourage feedback from the student throughout the process and have them complete an evaluation form when their sessions are complete. The Maths Centre Tutors should work alongside other staff who teach on the vocational programmes to facilitate and enhance the learning experience of students.

The new Maths Centre was advertised through a range of media including:

- the Irish Mathematics Learning Support Network (IMLSN) website (see http://supportcentre.maths.nuim.ie/mathsnetwork/NWRClaunch);
- an official opening on the 16th of October 2015 during Maths Week Ireland (see http://www.mathsweek.ie);
- the **sigma** newsletter in December 2015. (see http://www.sigma-network.ac.uk/wp-content/uploads/2015/12/sigmanewsletter9_Dec15.html#NWRC).

At NWRC, awareness of the Maths Centre was promoted through emails to tutors, flyers on STEM notice boards and Webtexts to students registered on STEM programmes. The Maths Centre also has a dedicated web information site http://www.nwrc.ac.uk/mathscentre.

Based on a review of the first year of operation, there are plans to expand the services of the Maths Centre considerably, see section 3 for more information.

## 3. Results from the Pilot study

The pilot study ran from February to June 2015 and involved students from the following disciplines: Access (Science, Combined Studies and Health and Welfare), Computing, Construction, Engineering, Mathematics and Science. The students who took part in the pilot were those who were struggling with their vocational programme, because they found the application of mathematics difficult. (See Table 1 for student attendance figures in the pilot study.)

Table 4. A breakdown of student attendance figures.

| Study Area | Number of students | Number of returners |
|---|---|---|
| Access / BSG | 8 | 0 |
| Computing / IT | 3 | 2 |
| Construction | 2 | 1 |
| Engineering | 1 | 1 |
| Health & Welfare | 1 | 0 |
| Maths | 1 | 0 |
| Science | 15 | 8 |

Mathematical knowledge and the ability to apply those concepts in other curriculum areas is a common problem. It is noted that successful execution of applications reinforces the numeracy and mathematical concepts learned and has the potential to strengthen the learner's motivation and achievement (William, 2016). Based on lecturers' observations, the students had a conceptual understanding of the basic concepts, however, correct application of their mathematical knowledge in specific situations was largely absent, e.g. applying number theory in computing.

Some of the students found difficulty with only a small number of mathematical concepts and once these were addressed the student did not return to the Maths Centre. The returners were those students who had significant problems with the mathematical concepts they encountered and so continued to attend the Maths Centre until the end of the pilot. Students typically chose to return due to the high level of service received and they were motivated to progress with their studies. Some of the student comments are included below:

*"I would have to drop out had it not been for the Maths Centre"* - Student from Edexcel Level 2 Extended Certificate in Engineering.

*"Have really benefited from the service, given different techniques and tips which have helped me greatly…I hope it will help me achieve the 71% (or more) grade I need for the entry to Podiatry at UU"* - Student from Access Diploma in Science

*"I had transferred from Northern Regional College and the course here was ahead so the Maths Centre helped me catch up"* - Student from Certificate in Higher Education Applied Medical Science.

The students were given a paper based diagnostic test on entry to the Maths Centre that identified their skills gaps. Once this was completed, a scheme of work was established for every student by the tutors and relevant vocational question sets were also created. The students were given only those question sets which were relevant to their area of study. Online support was also set up through Moodle, where the students could practise questions and complete quizzes each week in order to reinforce the tutorial sessions and show their understanding. This model of maths support is currently being written up in more detail and will subsequently be reported on with a full analysis of its impact on students.

At the end of the pilot, students were given a mathematical skills test which aimed to record any improvement and the findings were reinforced by their vocational lecturers' reports which showed a significant increase in the students' vocational attainment. The following comments were made by the lecturers (note these are not the students' real names):

"*Ciarán established good structure for laying out collision questions, which makes understanding easier. Excellent progress*"

"*Michael can confidently work with differentiation, just needed some assistance with product rule/quotient rule and chain rule. Excellent progress*"

In the past, these students would have lost interest in their vocational programme due to their lack of mathematical skills and dropped out. Based on this pilot, the findings suggest that the Maths Centre provision enhances students' mathematical ability and overall performance on their vocational area of study although further research would need to be carried out to define if the Maths Centre is the causal link between an increase in mathematical ability and a high overall attainment on their programme of study. A paper on the impact of maths support tutorials states that "*Small group tutorials are an effective method of mathematics support to enhance student mathematics confidence, performance and ultimately employability. However, in a fast changing and increasingly digital HE environment, additional support in the form of e-learning might benefit those students that prefer this form of learning*" (NCBI, 2014).

The Maths Centre is very new, but engagement and feedback has been encouraging. In addition to the attendance data (see Table 1), each student is asked to complete a review form assessing the provision; each lesson plan offers a feedback section for the student allowing them to raise any issues relating to the provision at each tutoring session, and each student accessing the provision will have an additional diagnostic test run at the completion of their tutoring in order to gauge progression. For example, one of the feedback comments stated:

"*I have a better understanding of the concepts underpinning my course*" - Student from Edexcel Level 2 Diploma for Information Technology practitioners.

Students attended from across a range of disciplines. Of the 31 participants in the pilot study, Access and Health and Welfare students had no returners. This was likely due to the fact that they joined the pilot at a late stage for exam revision and therefore were not long term referrals. For the more mathematically demanding courses, e.g. Construction, Engineering and Science, 12 students returned up to 6 times. These students were accessing the Maths Centre on a weekly basis and found it a great help to them. All the students were finding the application of mathematics very difficult and were contemplating leaving their course of study. This was borne out by talking to the students and members of the programme team. Most of the students were referred by tutors. As a follow up to the pilot study, it was found that 29 out of the 31 students who attended the Maths Centre passed their course of study.

It was also found from the information recorded at the visits that the students could not apply algebra to their chosen vocational subject, so the Maths Centre staff developed tutorial lessons devoted to the application of algebra. Baruah & Greenhow (2006) found that students' errors in calculus questions are often due to consistent algebraic errors (mal-rules), which is largely supported by the evidence of their answer files. The algebra tutorials appear to have had a positive impact on student examination performance within their maths modules, however, again further analysis is required. Meetings were held with the course directors to look at the individual students who were attending the Maths Centre and it was noted that the ones that attended the Maths Centre improved their maths scores significantly.

Although this was a small study, it did show that the Maths Centre is a viable aid to students struggling with the application of mathematics at NWRC and it suggests a clear positive impact on retention and success data within the College. The initial analysis of the first full year of operation (September 2015-June 2016) supports this observation and is currently being prepared for a future report.

## 4. Recommendations

Although the Maths Centre has been in existence for only approximately one year and four months, the following initial recommendations are being considered in order to strengthen the service for students:

- Diagnostic testing should be completed by all students studying any element of mathematics (within their STEM programme) during induction week;
- Procedures should be put in place to refer students who are weak in all or most aspects of mathematics to the Maths Centre;
- A drop-in centre approach should be adopted for those students who understand the main mathematical concepts but still occasionally need help;
- Short online tests need to be completed throughout the academic year to gauge student progress - these should be carried out within the Maths Centre;
- Student progress reports need to be sent to Curriculum Managers and disseminated to the course team via coordinators.

These points will allow for greater collaboration between the Maths Centre and the Schools teaching the courses. They will also allow for increased effectiveness of the supports on offer, and for students to seek engagement with the Maths Centre as normal. In addition to these recommendations, based on the initial success of the Maths Centre, there are significant plans for development in the near future with measures put in place to ensure that the College can:

- open the Maths Centre to all Schools within the College;
- develop various mathematical education modules and community programmes;
- bring an international conference in STEM to the city with an emphasis on the mathematical sciences.

In addition, it is intended to continue to develop links with the IMLSN, including involvement with their Special Interest Group to provide CPD to Maths Centre tutors and hosting the IMLSN annual workshop in 2017.

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