

## Forum Insights

## 631: TRANSITIONING TO E-ASSESSMENT IN MATHEMATICS EDUCATION

**2. Partners****📍 University College Cork**Tom Carroll ([t.carroll@ucc.ie](mailto:t.carroll@ucc.ie), (021) 4205811)Kieran Mulchrone ([k.mulchrone@ucc.ie](mailto:k.mulchrone@ucc.ie), (021) 4205822)**📍 Cork Institute of Technology**Áine Ní Shé ([aine.nishe@cit.ie](mailto:aine.nishe@cit.ie), (021) 4335123)Julie Crowley ([julie.crowley@cit.ie](mailto:julie.crowley@cit.ie), (021) 4326745)**3. Overview of the project as it has developed**

Poor student engagement with mathematics, especially in the case of students for whom the study of mathematics is ancillary to their main degree programme, is well-known to be problematic for students' progression and development. The problem is exacerbated by large class size and by pressures on lecturer and tutor time. Students are apt to 'tune out', thereby reinforcing a negative experience of mathematics that can have its roots early in their experience of the education system.

The main goal of this project is to leverage the potential of an online e-assessment platform for mathematics, namely Numbas, to integrate formative e-assessment into large, often as large as 500 students, first year service courses at UCC and CIT. Numbas has been developed at the University of Newcastle. It is actively maintained, freely available, and easy for students to work with straightaway. The original project proposal envisaged a project assistant, with strengths in mathematics and in computing, who would be employed at CIT for the duration of the project and who would develop content for courses at both institutions. Finding a single person with these skills who was also willing to commit to a long term contract has proven problematic. To minimize this delay, we decided to change tack and approach current postgraduate students who would work part-time on the project for a few months each. Catherine Costigan, a student on UCC's *MSc (Numerical Modelling and Scientific Computing)*, has joined the team as project assistant on a part-time basis for the summer. She is learning how Numbas works and beginning to create content. With regard to this aspect of the project, the main goal on UCC's side is to work towards introducing online tests for MA1001 and MA1002 Calculus for Scientists Parts 1 and 2 for the first time next term.

Evaluation of student outcomes has been to the fore in this project from the outset. A detailed description of an MRes (Master's by Research) in the College of Arts, Celtic Studies and Social Sciences (CACSSS) in UCC has been developed and advertised widely. The master's degree will be jointly supervised by Kieran Mulchrone and Tom Carroll and is funded by this award.

**4. Key outcomes of the project (link to any available material/resources)**

The project, while still in its initial stages, is gathering momentum. At UCC, we are working towards the introduction of e-assessment in *MA1001 Calculus for Science Part 1* and *MA1002 Calculus for Science Part 2* at UCC beginning in September. The relevant change to the assessment methods as described in UCC's formal 'Book of Modules' has been approved at the various levels of college administration and is in place for next academic year. The project assistant is currently producing Numbas content for these online tests in consultation with the lecturer, Martin Quirke, and the project team.

The project team has identified a number of key areas that are particularly problematic for students at both institutions. To give a few examples, in addition to basic mathematical skills such as algebra, transposition of formulas, scientific notation:

- descriptive statistics: where the dominant pedagogical approach is constructive rather than interpretive;
- probability: the connection between relative frequency and probability, understanding terms such as outcomes, events, sample space in concrete settings, the use of Venn diagrams to solve problems;
- waveforms: as used in engineering and physics, where students may not make the connection between notation used in their mathematics class and the notation used by physicists and engineers (phase, amplitude, frequency).

At CIT, a series of online tutorials and assessments for three first year Mathematics/Statistics modules for Business programmes have been run in 2014/15, involving approximately 450 students. The topics covered include:

- Getting Started with Numbas
- Arithmetic
- Algebra
- Descriptive Statistics
- Probability
- Probability Distributions
- Financial Mathematics

In Semester 1, there were 8 separate class cohorts for lectures and 21 lab groups. Students took a series of five short Numbas assessments, which were timed to run during lab time once every 2-3 weeks. Tests were devised in such a way that it was possible to provide many versions of the one assessment at a particular time, thereby preventing plagiarism. Of the final module mark, 20% was allocated to this series of assessments. Students engaged very well with this component of the

module throughout the semester, and lecturers reported that attendance at this component was very good. This assessment methodology was well suited to certain topics of that semester, for example, arithmetic and algebra.

At a review meeting at the end of Semester 1, the lecturing team decided that, while the regular testing did encourage students to attend, it caused pressure time-wise in regard to the more traditional tutorial work which was necessary at the latter end of the semester to prepare students for their end-of-semester examination, particularly in relation to descriptive statistics. As a consequence, it was decided to reduce the number of Numbas assessments for the Semester 2 module from five to three.

For the first 4-5 weeks of Semester 2, the topic to be covered was Probability, from elementary probability to the Binomial, Poisson and Normal Distributions. The lecturing team agreed that first year students still continue to find Probability very difficult; this is a disappointment, given the increased coverage of Statistics & Probability in the *Project Maths* syllabus. While students engaged well, results of the Numbas tests were lower than those of Semester 1, although students did fare better in the final topic of the module (Financial Mathematics). Particular effort was made to make the probability questions as granular as possible, in order to give partial credit, so as to encourage students.

Also – in relation to this project – CIT developed some Numbas resources for use in a non-credit bearing bridging course held for a specific cohort of engineering students in January, prior to their Semester 2 module in Calculus. Another lecturer used Numbas for testing 1st and 2nd year students of the module STAT6010 *Introduction to Statistics & Probability*. The first year group were non-standard students on a Springboard programme.

### 5. Outline how the project benefits the higher education sector nationally

There is an ongoing national debate on service teaching of mathematics at third level. The environment at Institutes of Technology in which this education takes place is very different from that in the Universities. For example, it is common that an Institute of Technology might not have a recognizable 'mathematics department'. A *Position Paper on Service Teaching of Mathematics*, drawn up by a sub-committee of the Irish Mathematical Society in 2009, identified several general issues in this area experienced across the third level sector.

<http://www.maths.tcd.ie/pub/ims/business/2008.09.02.serviceteaching.pdf>

That this project straddles the University / IoT divide, if that is what it is, is positive in itself. The mere existence of this project has already brought mathematicians at UCC and CIT closer together and has fostered regular interaction and sharing of experiences. We have much to learn from each other. One can hope that, as this project expands outside the Cork area, these benefits will be felt more widely.

From a lecturing perspective, the incorporation of online assessment into standard courses definitely eases the load with regard to marking, and this is of particular relevance in the IoT sector, where the average lecturer contact hours are 18-20 hours per week.

Numbas content encourages students to engage with Mathematics and Statistics, whether it is used as a tool to support learning in the classroom, or as an assessment tool. There is therefore a potential for a positive impact on student retention, though it is too early at this point to make a definitive call on this.

### 6. Outline how the project benefits students

The state examinations give rise, each year, to significant coverage in both the print and visual media, with the examinations in mathematics getting pride of place. This year has been no different. In addition to commentary on the papers themselves (with headlines such as 'Leaving Cert maths: Fury at ordinary level paper' including comments such as 'Question 6, on complex numbers, was an utter write-off'), some academic research made the national news. A paper in the *International Journal of Mathematical Education in Science and Technology*, describes the results of an analysis by Páraic Treacy and Fiona Faulkner of the correlation between students' leaving certificate grades and their risk of failing their first year mathematics course at UL, as determined by a diagnostic test that has been running there for over 10 years. The article itself appears at <http://www.tandfonline.com/doi/full/10.1080/0020739X.2015.1050707>

while some media reports are at <http://www.irishtimes.com/news/education/project-maths-linked-to-decline-in-third-level-performance-1.2242148>

and <https://www.siliconrepublic.com/portfolio/2015/06/09/project-maths-not-to-blame-for-results-third-level-maths>

This project sits squarely on the faultline between a shifting second level environment and the demands of third level where expectations of students' basic mathematical competence has remained high and is, in many cases, constrained by accreditation requirements. If anything, the transition from second to third level in Ireland is becoming even more problematic. The practical approach and frequent assessments does assist this by keeping students engaged, with lecturers at CIT reporting that attendance at the Numbas component was higher than at lectures in Semester 1. Students also found that the advice section accompanying practice questions provided them with instant support for questions they found difficult (although there is the risk that some students tended to give up on problems very quickly and jumped straight to the advice). The instant feedback on their progress is valued by students. In particular, through use of Numbas as an assessment tool, with assessments being submitted to Blackboard on completion, students had instant feedback on their performance in Continuous Assessment. Lecturers also had instant feedback on the overall profile of student results.

### 7. Other national/international development work that complements this project

Numbas being an open source tool, with a community of users, means that expertise and experience can be shared nationally and internationally. Lecturers of both UCC and CIT have already met and interacted with Dr Bill Foster and Mr Christian Perfect, both of Newcastle University, and it is intended to build further on that collaboration in the forthcoming academic year.

Lecturers at CIT and UCC have also assisted the initial development of the project *Assessment for Learning Resources for First Year Undergraduate Mathematics Modules* (Maynooth University, AIT, DCU, DkIT) through completion of their initial survey, and we intend to collaborate further with these project partners in 2015/16.

### 8. Next steps

Over the next number of months, we will continue to develop NUMBAS content for online assessment for the large first year UCC courses MA1001 and MA1002 in preparation for the new term on 7 September. We will conclude the recruitment of a suitable candidate for the MRes Degree who will evaluate the effect of the project on student outcomes and retention. Lecturers for other courses at UCC, including Dr Martin Kilian who teaches MA1100 *Introductory Mathematics for Business 1*, are considering how the work we are doing with Numbas might be able to benefit them and their courses.

On foot of the experience in CIT, it is planned to continue with the Numbas assessments in 2015/16, with a series of three assessments per module (for a total of 20% of the module mark). We also intend to reflect further on the effectiveness of this assessment methodology on student learning. The series of regular online assessments definitely had a positive effect on student engagement but such improvement in engagement tended to be limited to that component of the module. Performance in the end-of-semester summative examination paper was disappointing in Semester 1, so we think that it is too soon to make a definitive judgement on whether or not the use of a series of low stakes automated assessments had a positive effect on student learning, and in particular, on the ability of the student to synthesize all the learning involved in the module. In the meantime, we feel that the reduction of the number of Numbas assessments to three (over Weeks 3-11 of a 13 week semester) should be in keeping with the overall philosophy behind this assessment methodology, while allowing students space for more of the traditional tutorial work necessary for the end-of-semester examination. Hopefully, this should get the balance right: indeed, provisional examination results for Semester 2 (in which the number of Numbas assessments was reduced to three) indicate an improved performance in the end-of-semester examination paper. The research student funded by this project will be key to rigorously testing these as yet anecdotal findings.