

RESEARCH ARTICLE

An Evaluation of a Summer Mathematics Bridging Course for Mature Students

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Abstract

Each summer, the Department of Mathematics and Statistics at Maynooth University delivers a three-week bridging course for mature student applicants. This course serves a dual purpose. First, it acts as a refresher of fundamental mathematical skills, and second, for some, the summative assessments form part of the screening process to determine if their mathematics is of a sufficient level to make the move to higher education. This paper describes the results of student feedback on this course obtained through an online survey of past participants. Respondents indicate that not only is this course effective for building mathematical fluency and confidence, but that they also benefit from gaining a familiarity of the campus as well as making friends with their peers.

Keywords: Mature students, bridging course, mathematics, transition

1. Introduction

In Ireland, a mature student is generally defined to be anyone over 23 years of age on the first of January of the year they enter Higher Education (HE). At the University of Limerick (UL), Gill (2009) identified that mature students were struggling with the transition to HE mathematics. It is also known that mature students entering HE often have a sense of inadequacy, and these feelings are '*particularly acute in the initial stage of entry*' (Kearns, 2017, p. 181). As a result, to try and ameliorate these issues, in 2007 UL introduced a week-long intensive bridging course, named *Head Start Mathematics*, taught before the start of term. During the same period, and for similar reasons, Maynooth University (MU) established the Summer Mathematics Course (SMC). The SMC has two purposes. First, it should act as a refresher course for students who, on paper, have the mathematical standard to make the transition to HE but the time elapsed since they used their mathematical skills has caused a reduction in their fluency. Second, the SMC acts as part of MU's admission process to identify applicants whose mathematical skills are not yet at a sufficient level to facilitate an immediate move to MU degree programmes. Such students can be diverted to more appropriate bridging courses, such as the year-long Certificate in Science at MU (Mulligan and Mac an Bhaird, 2017).

In a 2011 report, the Irish Department of Education and Skills (DES, 2011) when analysing enrolment levels for new entrants to HE, predicted that the proportion of mature students would almost double

from 13% in 2009 to 25% in 2025. Contrary to this predicted increase, a recent study by the Irish Higher Education Authority (HEA) reported that the rate of mature student participation in HE has been steadily decreasing to 9% in 2018-19 (HEA, 2021). At MU, we found similar trends. The HEA report also added that *'The decline in participation from 2013 coincides with the reduction in unemployment, reflecting the impact of employment opportunities on the numbers of mature students...'* (HEA, 2021, p. 14). This decline in mature student applicants led, in 2020, to the MU Department of Mathematics and Statistics and the Maynooth Access Programme (MAP) Office considering the medium to long term future of the SMC. Evaluation of mathematical initiatives available to students is a key part of our research-based practices at MU and, as there had been no formal evaluation of the SMC previously, we decided that an important first step would be to survey student views about the course. As a result, in this paper we aim to answer the following research questions:

1. What is student opinion on the SMC?
2. What, if anything, can we do to improve the course?

First, we describe the SMC at MU, before providing a brief literature review of available research on similar bridging courses in Irish HE. We present the main themes which emerged from analysis of the survey responses, before discussing these findings in the context of related literature. We close by considering the answers to our research questions and the implications for the future of the SMC.

2. Summer Mathematics Course and Mature Student Entry to MU

The first two weeks of the SMC reviews topics such as arithmetic, fractions, algebra, logarithms, coordinate geometry and trigonometry. During this period, students receive five two-hour lectures, with each lecture supported by two two-hour lab sessions. In these labs, students are provided with practice problems and there are two tutors available to assist with any queries that may arise. Students also have computer access during these sessions to aid their study. At the end of week two, students sit an exam containing 20 multiple-choice questions on the topics covered. Furthermore, dispersed through the two weeks are a mix of extra events, such as guest lectures on general science topics as well as tours of the historic Russell Library (<https://www.maynoothuniversity.ie/library/collections/russell-library>) and the National Science and Ecclesiology Museum (<https://museum.maynoothcollege.ie/>), which are both situated on campus.

Week three topics include simultaneous equations, linear inequalities, coordinate geometry of the circle, polynomial division, cubic equations, the unit circle and further trigonometry. Each day, from Monday to Thursday, students receive a two-hour lecture followed by a two-hour lab session. At the end of this week, there is an exam containing 20 multiple-choice questions.

The application process for mature students to MU is similar to that at other Irish institutions (HEA, 2021). However, mature students who apply for a degree programme at MU, on which there is a mathematical component, must take an initial competency test to assess their basic mathematics knowledge. If they pass, they are then called for interview. The interview panel then make one of the following recommendations based on the candidate responses, their mathematical background, and the mathematical content of the degree they have applied for:

1. They are offered a place on a degree programme with no conditions.
2. They are referred to attend the full three weeks of the SMC.
3. They are referred to attend the first two weeks of the SMC.
4. They are referred to attend just week three of the SMC.

If a student is referred to attend the SMC, their place in MU may be conditional on passing the associated exams.

3. Literature Review

In 2021, the HEA in Ireland published a comprehensive study on mature student participation in HE. In this study, they briefly discuss the provision of what they term as foundation/bridging courses, which they state are available in many institutions in Ireland. They suggest that ‘...*the funding and provision of foundation/bridging courses in advance of attending a mainstream HEI [HE Institution] course can greatly assist students.*’ (HEA, 2021, p. xix). Courses ‘...*can also help introduce students to the college campus, its facilities, and the daily routine of the life of a student.*’ (HEA, 2021, p. 55). While this study also alludes to the success of such programmes, it does not provide direct evidence. A literature review identified publications available on year-long bridging courses in Ireland, many of which are accredited, for example O’Sullivan et al. (2017), but the authors found just four articles which relate to short non-accredited courses similar to the SMC at MU. It is not clear whether engagement with these courses plays any role in subsequent student admission to the HEI, though one mentions an end of course exam.

Gill (2009) observed that first-year mature students in UL were having difficulty catching up with the fundamentals of mathematics while simultaneously maintaining their other studies. As a result, while on secondment with sigma (<http://www.sigma-network.ac.uk/>), Gill developed *Head Start Mathematics* (<https://ulsites.ul.ie/cemtl/head-start-maths-workbooks>), a week-long course taught before the start of term to aid mature students in their transition to HE. Gill (2010) established that engagement with the course impacted on student self-concept, and in both papers student responses indicated that their participation ‘...*was enormously affirmative and made for a positive experience for all involved.*’ (Gill, 2009, p. 37). In 2010, *Head Start Mathematics* was expanded to a two-week course and, in a follow-up study, Johnson and O’Keeffe (2016) identified an increase in the retention rates of undergraduate adult learners who participated in *Head Start Mathematics* compared to those who did not.

Cork Institute of Technology (CIT), in 2010, introduced *Maths for Matures*. O’Neill (2013), in an article which largely focusses on the structure and purpose of the course, describes how it is offered to mature students who are intending to apply for entry to a full-time science or engineering undergraduate programme. They outline 14.5 hours of instruction, delivered three evenings per week, over a three-week period and include positive and encouraging quotes from past participants, for example ‘*It has given me belief in knowing that I can do something if I apply myself fully. It has also given me increased confidence in maths.*’

4. Methodology

The authors designed a survey consisting of tick-box and open-response questions which were hosted on onlinesurveys.ac.uk, see Appendix A for a sample of the open-response questions completed by participants. Ethical approval was granted, and the survey was launched in the spring of 2021. Participants from 2012-2020 were invited to complete the survey via various appropriate mailing lists. In total, 32 responses from a possible 190 were gathered, a response rate of approximately 17%. The tick-box questions focussed on participant background and were intended for cross-referencing with the open responses. However, due to the homogeneous nature of participant backgrounds, this analysis revealed no further insight. All 32 respondents had proceeded to study at HE on completion of the SMC with 28 of these choosing to study at MU.

As the substance of the survey contained mostly open-response questions, the authors chose Thematic Analysis (Braun and Clarke, 2006) to analyse the collected data, as it is a ‘*reliable tool...[to] identify a set of themes that reflect the essence of textual data, and to discover recurrent patterns.*’ (Sarantakos, 2012, p. 379). To this end, the authors coded the open responses individually and noted the main themes that emerged. They then met to discuss any discrepancies and agree on the

final themes, which are reported in Section 5. Respondent comments often fell under more than one theme.

5. Results

In this section, we describe the five main themes that emerged from the analysis of the survey responses: mathematical preparation, confidence, transition, social and course format.

By far the most dominant theme was the ‘mathematical preparation’ for HE provided by the SMC. Respondents made mainly positive remarks, for example *‘Prepared me for university mathematics, giving understanding of basic language and principles on which calculus was extended in modules. Without this summer course, I would have not be[en] able to keep up in lectures’*. Students elaborated on this point by adding that they appreciated how the basics were covered: *‘I liked that things were explained from a standpoint of a complete beginner rather than assuming prior knowledge. This really helped when working with harder material. It’s always the most basic maths that comes up very often in my studies at college, and this course helped clear things up in that regard’*.

Furthermore, several student comments placed additional emphasis on the importance of this preparation as the SMC had made them realise how much their mathematical fluency had diminished over time: *‘The course opened my eyes to how out of practice I was with maths and how much I had forgotten’*. While others added that, as a result of the SMC, they also recognised the need for extra study: *‘...my education gap was larger than what was taught [on the SMC] so a lot of self-learning had to be involved to pass the first year in mathematics and physics’*.

Three respondents felt that the SMC did not prepare them for the subsequent level of mathematics at HE: *‘It is so much easier than anything actually encountered during degree studies’*.

Thematic analysis also identified increased student ‘confidence’ as a result of the SMC as a major theme within student comments. For example, *‘It gave me the confidence to get through third level and also a taste for maths which I never would have thought possible given my horrible history with maths at second level. In fact, I changed my degree to general science in order to continue the subject’*. Others commented on an increase in their self-efficacy and how participation alleviated their initial concern about studying mathematics: *‘I was initially apprehensive about returning to education at my age and trying to learn maths etc. Realising how well I did, how much I learnt, and how much I enjoyed the course, definitely reinforced my decision to return to education’*.

Another theme to emerge from student responses was one of ‘transition’. Comments referred to the benefits of the SMC in easing their subsequent orientation and integration to university life: *‘[I was]...much better organized when progressing to third level. I was also familiar with the buildings used by the mathematics department and even some of the tutors, which really helped’*. In a similar vein, others remarked that *‘It was an intimate setting so there were plenty of opportunities to ask questions. It definitely was a good insight into what lay ahead for anyone undertaking maths as part of their degree’*. Within this theme, there were a small number of suggestions on how the SMC could be enhanced to further improve transition. For example, *‘The lab session time could be better used to familiarize people with the software used in the mathematics department. I realize it might be seen as giving an unfair advantage, but the majority of people on the course are at a natural disadvantage due to not coming from a traditional education background and this could help them assimilate to university level’*.

Closely related to this theme were the ‘social’ supports that evolved for students as a result of attending the SMC. For example, *‘I really enjoyed the social aspect and as I suffer from anxiety, knowing the campus before September was of great benefit’* and *‘[The lecturer] and the other*

students were very friendly and it was great to already know some people when I started in September. One of them is a very close friend 5 years later'. The importance of these enduring friendships made during the SMC were acknowledged by other respondents: *'I also made friends during the course which was extremely helpful when I started in the college. I'm best friends to this day with a friend I made during this course, and he encouraged me throughout. If it wasn't for this program, we may not have met'*.

The final theme identified across student responses was the 'format' of the SMC, with some comments providing extensive detail, for example *'I really benefited from all aspects of the summer maths course and I really enjoyed all of them. The lectures given by [the lecturer] were excellent and the follow-up lab sessions really emphasized the lecture material we were given. The guest lectures and tours etc. really complemented the course. It gave us a chance to socialise, meet new people, make new friends and become familiar with Maynooth campus'*.

Several respondents appreciated the timing of the different course features: *'The course structure was pleasant with morning lectures afternoon lab sessions and guests in the midst to break the day/week. Enjoyed the tour of the old library and group lunches'*. While others associated these course features with an enjoyable learning experience: *'I thought it was really nicely set up with the tour and history of maths lecture. It really opened my eyes to the wonder of maths. I liked the lab sessions because it gave you a chance to work on problems and get some one-on-one help. [The lecturer] is an amazing teacher and made me feel relaxed and less intimidated by the subject'*.

There were some suggestions relating to changes to the course format, focusing on either extending its duration or including more advanced material, *'Include some basic calculus, like differentiation and integration'*.

6. Discussion and Conclusion

The issue of students entering HE without the required levels of mathematical proficiency is known as *the mathematics problem* and has been widely documented (Lawson et al., 2012). The SMC was established to go some way to tackle this issue for mature students entering MU. Analysis of the survey responses, although we received no responses from students who did not continue to HE after the SMC, seems to indicate that the SMC has been broadly successful in this regard and, given the heterogeneous nature of mature students (Ryan & Fitzmaurice, 2017), it is reassuring that overall, there is a high degree of satisfaction with the SMC. The fact that all respondents to our survey continued to HE after the SMC is a possible limitation to this study as self-selection may have introduced some bias.

The five themes which emerged from student responses provide answers to our first research question. Students felt that the SMC facilitated increased mathematical preparedness and confidence in their own abilities, both of which are crucial for progression through HE (Parsons et al., 2009). It is also evident, from the format, social, and transition themes, that respondents identified that the SMC gave them the opportunity to familiarise themselves with campus and the facilities available, a key aspect of such courses as outlined by the Department of Education and Skills (DES, 2021). In particular, students seemed to appreciate how the course lectures and labs were punctuated by guest lectures, and tours. Furthermore, bridging courses can also *'help break the barriers of age groups and develop interactions among participants.'* (DES, 2021, p. 55), and evidence for these social interactions was very clear in our study, from lunches to establishing long-term friendships. This bonding is an essential part of a successful support network for students because *'Students learn together in class, while friends, classmates and study partners learn together outside of college campus'* (Lei, 2010, p. 156).

In relation to the second research question, a small number of responses seem to indicate that the precise function of the SMC within the pathway to HE might be better communicated. For example, suggestions that the SMC be extended and that it include some calculus. Calculus is not included in the SMC as this topic is taught from a beginner's perspective in the first year of mathematics at MU. A few respondents also suggested that the SMC did not prepare them for HE. This has caused us to reconsider the multiple-choice nature of the summative examination and the inclusion of grading of full solutions which may provide a better picture of student knowledge.

7. Future Work

Due to COVID-19 the SMC was delivered online in 2020 and 2021, and there was increased engagement with and completion of the SMC from registered students when compared to previous years. This seems at odds with general student online engagement during the pandemic (Mac an Bhaird et al., 2021). Three of the survey respondents took the SMC during this time and they provided both negative and positive comments on their online experience. However, one possible explanation for increased engagement with and completion of the SMC during this period is the flexibility that online study offers mature students as it allows them to fit education around their varied commitments (HEA, 2021). Combined with the positive feedback from Section 5 regarding the in-person SMC, we are considering a hybrid model for the medium to long-term, combining the best elements of both online and in-person SMC. We also plan to continue our research in this area, for example, a study of degree completion rates at MU for past participants of the SMC.

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9. References

Braun, V. and Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), pp.77–101. <https://doi.org/10.1191/1478088706qp063oa>

Department of Education and Skills, 2021. Study of Mature Student Participation in Higher Education, *Department of Education and Skills*, Dublin. Available at https://hea.ie/assets/uploads/2021/06/Study-of-Mature-Student-Participation-in-Higher-Education_June-2021.pdf [Accessed 18 January 2022].

Department of Education and Skills, 2011. National strategy for higher education to 2030: report of the strategy group, *Department of Education and Skills*, Dublin. Available at <https://hea.ie/assets/uploads/2017/06/National-Strategy-for-Higher-Education-2030.pdf> [Accessed 18 January 2022].

Kearns, M., 2017. Mature Student in Higher Education. In Fleming, T., Loxley, A. and Finnegan, F., eds. *Access and participation in Irish higher education*. Springer. pp.177-196

Gill, O., 2009. Head Start Mathematics. Report on a programme for adult learners of mathematics returning to higher education. *Proceedings of the CETL-MSOR Conference 2008*, Lancaster University, pp.33–37.

- Gill, O., 2010. Evaluating the Impact of a Refresher Course in Mathematics on Adult Learners. *Proceedings of the 17th international conference of adults learning mathematics (ALM)*, Vox, Norwegian Agency for Lifelong Learning, Oslo, Norway, pp.37–46.
- Johnson, P. and O’Keeffe, L., 2016. The effect of a pre-university mathematics bridging course on adult learners’ self-efficacy and retention rates in STEM subjects. *Irish Educational Studies*, 35(3), pp.233-248.
- Lawson D. A., Croft, A. C. and Waller, D., 2012. Mathematics support past, present and future. *EE 2012 - International Conference on Innovation, Practice and Research in Engineering Education, Conference Proceedings*, pp.1-9
- Lei, S. A., 2010. Intrinsic and Extrinsic Motivation: Evaluating Benefits and Drawbacks from College Instructors' Perspectives. *Journal of Instructional Psychology*, 37(2), pp.153-160.
- Mac an Bhaird, C., McGlinchey, A., Mulligan, P., O’Malley, J. and O’Neill, R., 2021. Student experiences of online study groups and drop-in mathematics support during COVID-19. *Teaching Mathematics and its Applications: An International Journal of the IMA*, 40(4), pp.356-373.
- Mulligan, P. and Mac an Bhaird, C., 2017. Motivating Mature Students of Mathematics. *MSOR Connections*, 15(3), pp.36-43.
- O’Neill, S., 2013. Mathematics as a Barrier for Mature Students – Initiatives developed within Cork Institute of Technology as a response. In *14th Biennial CSSI Conference 2013: Mind, Body, Spirit: The Holistic Approach to the Student Experience Conference Proceedings*, pp. 93-99.
- O’Sullivan, C., Robinson, P., Keogh, J. and O’Neill, J., 2017. Models of re-engaging adult learners with mathematics. *Teaching Mathematics and its Applications: An International Journal of the IMA*, 36(2), pp.81-93.
- Parsons, S., Croft, T. and Harrison, M., 2009. Does students’ confidence in their ability in mathematics matter? *Teaching Mathematics and Its Applications: An International Journal of the IMA*, 28(2), pp.53-68.
- Ryan, M. and Fitzmaurice, O., 2017. Behind the Numbers: The Preliminary Findings of a Mixed Methods Study Investigating the Existence of Mathematics Anxiety among Mature Students. *Adults Learning Mathematics*, 12(1), pp.49-58.
- Sarantakos, S., 2012. *Social research*. Macmillan International Higher Education.

Appendix A

The following are a representative subset of the open-response questions which participants answered in our survey. The main themes which emerged from the coding of responses to these questions are presented in Section 5.

1. When you applied to Maynooth University, why were you interested in returning to education?
2. What aspects of the Summer Mathematics Course did you like/dislike? Eg, lectures, lab sessions, guest lectures, library and museum tours, etc.?
3. In what ways did you find the Summer Mathematics Course useful/not useful?
4. If you could make any changes to the Summer Mathematics Course, what would they be?
5. Did your experience of the Summer Mathematics Course reinforce your decision to consider third level education? Please explain.
6. Do you feel the Summer Mathematics Course adequately prepared you for your mathematics or mathematics related studies at third level? Please explain.
7. Did the Summer Mathematics Course influence your decision to choose a course that has mathematics as a core element? Please explain.