

Mentoring students can lead to increased engagement and success with mathematics

Ciarán Mac an Bhaird

Department of Mathematics and Statistics, National University of Ireland Maynooth.

Abstract

In September 2009, the author commenced a research project with colleagues to investigate the reasons why students do or do not engage with mathematics. The initial stages of this project involved contacting and meeting students who were repeating at least one of their first year mathematics modules. The author decided to offer the students an opportunity to participate in a mentoring scheme. This paper will describe the scheme, the mathematical background of the students and focus on their engagement levels, their behaviour and feedback. We look at the students' reactions when they were asked to bring in their attempted work. We also present evidence that suggests a positive impact on student progression, and we will briefly present the outcomes of the project in terms of how it impacted on further initiatives and interventions run by our department.

1. Introduction

Increasing numbers of students who struggle with basic mathematical skills are entering third level education [1-2]. One response has been the establishment of a range of mathematical learning support initiatives to help students to adjust to third level mathematics [3-4]. Several studies have been carried out to measure the effectiveness of these initiatives [5-7].

A common feature in much of this research is the observation that a significant minority of at-risk students, those most in need of the support, are not availing themselves of the support available. This had led to a number of recent studies to investigate the reasons behind this lack of engagement [8].

At the National University of Ireland Maynooth (NUIM) we started a research project in September 2009 to identify the reasons why students do or do not engage with mathematics. We contacted 39 students who were repeating at least one module of mathematics and asked them to participate in this project. The author decided to offer a mentoring service to these students to help them overcome their difficulties.

In this paper we will describe the mentoring process. In particular we report on the mathematical backgrounds of the students involved (mentees), how they participated with the project and report on any changes in their behaviour and their engagement levels. We will compare them to students who did not avail themselves of the mentoring process and we will also briefly present anonymous feedback from the mentees. Finally, we will discuss how the results of this project have helped to guide the Mathematics Support Centre (MSC) and the Department of Mathematics and Statistics in the establishment of additional initiatives to target these students.

2. Methodology (The mentoring process)

The author rang and emailed 39 students in October 2009 to inform them about the research project and ask if they wanted to be involved. At this stage students were made aware of the availability of the mentoring process and were invited to arrange a meeting with the author to discuss the research project and the potential mentoring scheme. Eighteen students responded and 14 agreed to participate in the mentoring scheme. Two of these students subsequently did not avail themselves of the scheme.

The author and the mentees agreed to meet once every fortnight for 20-30 minutes; all meetings were on a one-to-one basis in the author's office. The meetings involved discussions of the student's experiences, and the importance of working on and submitting assignments. In particular, mentees were encouraged to try material they were not comfortable with and advised on how they could deal effectively with incorrect solutions or approaches by using the wide range of supports available. Students were encouraged to avail themselves of free help in the MSC, to become independent learners and to engage fully with mathematics.

The amount of mathematics covered during these sessions was minimal, and the majority of the time was spent discussing study methods, time management and effective use of resources. Students were encouraged to raise one mathematical issue each week that they were struggling with, to show their attempts and the author would try to clarify this for them. All mentees were asked to look at previous exam papers over the Easter break. Students were not required to do the questions; rather they simply had to note the questions that they thought they could solve, the technique they would use and how they would start a solution.

Towards the end of the first semester the department made the author aware of 2 additional students who were experiencing difficulties with mathematics. They were both second year students and were included in the project. Information on these students is not included here as they were, for the most part, studying different modules. For the last 3 weeks of semester two, the meetings were increased to once a week. This was possible due to the decreased engagement levels of some of the mentees.

The author maintained written records of all the meetings and issued an anonymous questionnaire to the participants at the end of the year with basic questions on the project. The author also had access to most of the students' records of engagement with mathematics. He received their permission to use these records anonymously to help measure the impact of the scheme. Some of the records are incomplete and numbers are given out of the total number of records available for that student and activity. Prior to the commencement of the scheme, the author researched material on similar projects and found an interesting overview of a variety of work on student mentoring and peer tutoring [9-10].

3. Results

The 12 first year mentees were composed of 6 students doing Science or a variation, e.g. Biomedical Science, and 6 students taking Mathematical Studies which is mathematics for Arts and Finance Students. Three of these were doing Finance and Accounting in which mathematics is compulsory in first year, 2 were Arts students who has chosen to do mathematics and the final student was doing Finance and had also chosen to do mathematics. Mathematics is compulsory in first year Science. All mentees were repeating modules of mathematics internally which meant that they were expected to attend the appropriate lectures and tutorials and complete the necessary assignments which would form part of their continuous assessment.

Eleven of the mentees were deemed at-risk, and 1 was not deemed at-risk. We describe students as at-risk if they have failed an incoming diagnostic test (less than 21 out of 60) or have a B1 or lower in ordinary level Leaving Certificate mathematics. We believe these students stand a high risk of failing first year mathematics at NUIM if they do not actively engage with the support available.

Of the 27 students who did not participate in the project, 21 made no response, and 14 of these were at-risk, 5 were not. The remaining 6 (4 at-risk and 1 not) did respond initially but did not participate in the mentoring scheme.

3.1 Students who responded but did not engage with the mentoring scheme.

Three students responded to the initial telephone contact but did not meet with the author. Two of these were at-risk and blamed personal (not mathematical) issues for their problems in first year. Both these students were registered with the Disability Office at NUIM. The mathematical background of the other student was unknown. All 3 students displayed extremely low levels of engagement in 2008-9; they never visited the MSC, sat none of their exams and deregistered from NUIM in 2009-10.

Three other students responded and agreed to visit the author. The first student was not at-risk and was repeating second semester modules only. They agreed to meet with the author at the start of that semester but did not attend and did not respond to any subsequent contact. In 2008-9 the student had shown good engagement levels in semester 1 (and passed) and very low levels in semester 2 (and failed). In 2009-10 they had better levels of engagement in semester 2 and passed by compensation, though they had failed 7 out of a total of 9 exams taken in mathematics.

The remaining 2 students met with the author and were both taking science. They agreed to partake in the mentoring project, and one also agreed to be interviewed as part of the related research project. It was clear from the initial meetings that both students were extremely nervous about mathematics, they were afraid to ask questions and did not want to do mathematics the wrong way. Both were at-risk students and extremely weak. They failed to engage with the mentoring scheme after the initial meeting and did not respond to subsequent attempts at contact. In both years they showed relatively good attendance records in lectures, however their attendance at the smaller tutorials and their submission of assignments was very low. Neither of them ever attended the MSC and they failed 20 out of a total 24 mathematics exams taken. They have both now left NUIM.

3.2 Students who did not respond.

Twelve of the twenty one students who did not respond to any contact failed to progress into second year in 2009-10. Ten of these were science students and 2 were mathematical studies students.

Year	Record Details	Tutorials	Lectures	MSC	Homework	Exams failed	Exams Absent
8-9	8/10	41/160	53/192*	10	8/56*	37/48	5/48
9-10	10/10	44/167	-	4	43/167	36/40	3/40

* One student accounted for 23 lectures and for 5 assignments.

Table 1: Non-responders in Science who failed

The engagement details of the 10 science students are included in Table 1, though they submitted an increased percentage of assignments in 2009-10, there was no marked improvement in their performance or attendance. 9 of these students were at-risk and 1 was not at-risk. Of the 2 mathematical studies students, 1 was absent from all exams and had practically zero engagement with mathematics. The second student showed increased engagement in 2009-10 and passed 3 modules. They passed the fourth module in 2010-11.

The remaining nine non-responders progressed into second year, 5 of these were at-risk and four were not. The engagement details of the 7 science students are included in Table 2. Four of them passed their exams and 3 passed by compensation. Again, there was no marked increase in their engagement levels but these students had, on average, better mathematical backgrounds than the students who failed, and had fewer exams to repeat. Both mathematical studies students who passed were not at-risk and had very low engagement levels in 2008-9, e.g.

attended 5/40 tutorials and had very low continuous assessment grades. They both showed a marked increase in 2009-10, e.g. attended 14/42 tutorials and completed 23/41 assignments.

Year	Record Details	Tutorials	Lectures	MSC	Homework's	Exams failed	Exams Absent
8-9	7/7	66/140	69/168	10	21/49	29/44	3/44
9-10	7/7	43/84	-	9	43/84	9/17	8/17

Table 2: Pass non-responders in Science

3.3 Mentees

Of the 12 first year mentees, 11 were at-risk and 1 was not. If we consider the 12 students in total, they showed a marked increase in their levels of engagement, especially in terms of their assignment submission and visits to the MSC.

Year	Record Details	Tutorials	Lectures	MSC	Homeworks	Exams failed	Exams Absent
8-9	12/12	95/220	50/144	16	9/49	65/81	3/81
9-10	12/12	92/193	-	57	133/193	21/41	0/41

Table 3: Records of mentees

3.3.1 Mentees who failed to progress

Three mentees failed to progress to second year and they had amongst the lowest levels of engagement with the mentoring process. The author was not surprised by this outcome. They were all at-risk, had very weak mathematical backgrounds and repeatedly failed to deal directly and appropriately with their mathematical issues. They attended a total of 17 meetings and rearranged or cancelled 15 meetings. Their surface engagement with mathematics did increase, going from 9/40 tutorials in 2008-9 to 28/54 in 2009-10. In 2008-9 they submitted 2/40 assignments and 33/54 in 2009-10. They also attended the MSC but only during the last weeks of term.

Their lack of effective engagement with the scheme was highlighted by their complete failure to bring any of their attempted work to the sessions. When asked to bring in their material on exam papers after the Easter break, one student forgot their bag, a second said that their computer had crashed and the third missed the next two sessions. All three students stayed out of contact for several weeks in the middle of the term and only arrived back during the last week of term. They brought in questions that they said they could not do, but never brought in attempts. Despite repeated assurances from the author that it was important to bring in attempts and that this was the best way to identify weaknesses and make progress, it was clear that they were afraid of showing lack of knowledge and showed constant signs of performance avoidance. This is consistent with the initial findings of the research project [11-13] which all three participated in. Two of these students have left NUIM and the third, while still registered, has never taken a mathematics exam since.

3.3.2 Mentees who passed by compensation.

Three mentees passed by compensation. All 3 had very weak mathematical backgrounds and were deemed at-risk. They met with the author a total of 21 times and they rearranged or cancelled 8 times. Their submission of assignments did increase, rising from 4/57 in 2008-9 to 30/51 in 2009-10. Their attendance at tutorials dropped. They also attended the MSC but only 9 times in total compared with 10 times in the previous year. Again, none of these students brought in material on the exam papers.

Two of these mentees were registered with the Disability Office in NUIM and struggled to engage on a regular basis. They were receiving private tuition, and though they rarely brought in attempts to the author, it was clear from their queries that they were making some effort to address their problems. They did not bring in their work on the exam papers but both said they had brought it to their private tutors. They did not use their disabilities as an excuse and appeared to be straight talking, and willing to try and address their mathematical issues. The author was not confident that they would pass, but they did give themselves a chance.

The third mentee was extremely inconsistent in their behaviour and repeatedly failed to deal directly with their issues with mathematics. They said that they were attending all tutorials, going to the MSC on a regular basis and submitting all their assignments. This contradicted the records, though they were doing some work. This student never brought any attempts to the author and said that they had done everything they had been asked to do and had no problems. This was clearly not the case and when pushed on these issues the student would fail to show for a few weeks. They also said that they had looked at the exam papers and had some problems but they never brought these in. The author was not confident that this student would pass and was surprised that they progressed into second year.

3.3.3 Mentees who passed

The 6 mentees who passed engaged to a high level with the mentoring scheme. Five of them were at-risk but showed determination to get through. They attended 41 meetings and cancelled 12 times. One student accounted for 6 of these cancellations. This student had a full time job in a different part of the country. Only one of these students had a very weak mathematical background and they all showed increased engagement with mathematics, though their initial engagement was not as low as the other groups. In 2008-9 they attended 54/120 tutorials and handed in 44/120 assignments. In 2009-10 this rose to 50/82 tutorials and 64/82 assignments. They also attended the MSC a total of 33 times as opposed to 2 times in 2008-9.

Five of these students dealt directly with their mathematical issues, they consistently brought in questions and all of them had the exam paper material dealt with as requested and even had a list of follow up questions. They gave a wide range of reasons for their problems in first year including part-time jobs, personal problems, laziness and financial distress. It was not difficult to mentor these students.

The remaining student failed to directly deal with their mathematical issues. This student was very similar to a previous student in that their responses were always extremely inconsistent. For example, the student consistently received 100% in continuous assessment and could not understand how they had failed first year. The student had a severe lack of understanding of the basics of mathematics. When pushed on this issue by the author, the student admitted that all assignment solutions in their first year were copied from peers or found on-line. The author pointed out the folly in this approach, but was never satisfied that the student stopped. This student also failed to bring in any attempts or material related to the exam papers. The student consistently asked the author to do solutions to questions from exam papers and when the author refused to do so, the student's engagement levels decreased. The author was surprised that this student passed.

4. Student Feedback.

The author gave an anonymous questionnaire to all 12 mentees at the end of the second semester before they sat their exams. Nine were returned and in fact these were from the students who actually progressed into the next year of their studies.

As one would expect from a questionnaire on such a scheme, the responses were all positive. In particular, the students highlighted the importance of knowing that there was someone that they could talk to about their experiences, the importance of being consistently encouraged and advised about the correct supports to avail

themselves of and a constant reaffirmation of the progress that they were making. They reported that the fact there was someone monitoring their behaviour was an added impetus to get the work done. They also stressed how significant it was that they were contacted by the department directly as they thought that they were unlikely to seek help themselves.

The following responses are typical:

What was your experience of maths before being contacted? *"Very distant and detached, I didn't get involved at all and once I wanted to, I didn't know where to start"*

Would you have sought help if not contacted? *"I don't think I would've looked for help, I probably would have just put it on the long finger and hope for the best"*

Did you benefit from the mentoring? *"I feel much better knowing I have someone definite to talk to, also this motivated me to try and work on the hard stuff without fear of failure"*

Has your behavior towards Maths changed? *"I attend more now that I know if I don't understand something in class etc., I can talk about it later rather than just getting annoyed and being put off from going again."*

5. Conclusions

Students who do not engage with mathematics are often unwilling to admit to themselves that they have a problem with mathematics and often experience fear and embarrassment in relation to mathematics [11-13]. The purpose of this mentoring project was try and assist non-engaging students to engage appropriately, to encourage them to admit to themselves that they have a problem and advise them on how best to seek help.

It is impossible to make any sweeping statements as a result of this scheme. As is normal for these types of initiatives, there is always a law of diminishing returns. Every additional intervention is aiming to target students that did not engage or receive benefit from a previous or existing support. These are the students who remain always in our minds, what new effort we can make to help these students, for example the three 'at-risk' students who did not engage fully and failed to progress, or the two 'at-risk' students who agreed to join the mentoring scheme but failed to do so and also failed to progress.

However, overall the process was a very rewarding, if somewhat frustrating experience for the author. It was extremely time-consuming but the positives far outweighed the negatives. The majority of the mentees increased the range and quality of their engagement with mathematics. Nine of the twelve first year mentees (8 of these 'at-risk') proceeded into second year and it is reasonable to assume that not all of these would have succeeded without the scheme. For example, if we look at the records of the 18 at-risk students who did not avail of the service, we see that 13 of these failed to progress.

The positives of the scheme led the author and a colleague to apply for and receive a scholarship from the Centre for Teaching and Learning in NUIM towards the establishment of a peer mentoring scheme. This scheme commenced in September 2011 and specifically targeted approximately 40 of the most at-risk students entering mathematics at NUIM. Initial records indicate that the vast majority of mentees are engaging with the process. We look forward to reporting on this scheme after a full year of operation.

References:

1. Gill, O., O'Donoghue, J., Faulkner, F., Hannigan, A. (2010) Trends in performance of science and technology students (1997–2008) in Ireland, *International Journal of Mathematical Education in Science and Technology*, 41, (3), 323-339.

2. Organisation for Economic Co-operation and Development (OECD) (2003). *Learning for Tomorrow's World – First Results from PISA 2003*. Paris, OECD.
3. Gill, O., Johnson, P., O'Donoghue, J. (2008) An Audit of Mathematics Support in Irish Third Level Institutions. CEMTL: University of Limerick.
4. Pell, G., Croft, T. (2008) Mathematics Support – support for all?, *Teaching Mathematics and its Applications*, 27, 167-172.
5. Patel, C., Little, J. (2006) Measuring Mathematics Support, *Teaching Mathematics and its Applications*, 25, 131-138.
6. Lee, S., Harrison, M., Pell, P., Robinson, C. (2008) Predicting performance of first year engineering students and the importance of assessment tools therein, *Engineering Education*, 3, 44-51.
7. Mac an Bhaird, C., Morgan, T., O'Shea, A. (2009) The impact of the mathematics support centre on the grades of first year students at the National University of Ireland Maynooth, *Teaching Mathematics and its Applications*, 28, 117-122.
8. Symonds, R. (2008) Evaluating Students' Engagement with Mathematics Support. PhD Thesis. Loughborough University.
9. Bidgood, P. (2004) Student mentoring and peer tutoring, *MSOR Connections*, 4 (1), 12-16.
10. Kane, S., Sinka, I. (2009) Good practice in undergraduate peer support, *MSOR Connections*, 9 (4), 11-14.
11. Grehan, M., Mac an Bhaird, C., O'Shea, A. (2011) Why do students not avail themselves of mathematics support? *Research in Mathematics Education*, 13 (1), 79-80.
12. Grehan, M., Mac an Bhaird, C., O'Shea, A. (2011b) How do students deal with difficulties in mathematics? In Green, D. (Ed) *Proceedings of the CETL MSOR Conference 2010*, 34-38.
13. Grehan, M., Mac an Bhaird, C., & O'Shea, A. (2011c). The effects of social interactions on engagement with mathematics. In Corcoran, D., Dooley, T, & Ryan, M. (Eds) *Proceedings of the 4th Conference on Research in Mathematics Education (MEI 4)*. 180-191.