

# THE EFFECTS OF SOCIAL INTERACTIONS ON ENGAGEMENT WITH MATHEMATICS

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*In spring 2010 nine undergraduate students were interviewed about their experiences of first year mathematics. All nine students had passed their first year examinations and had engaged with mathematics to some extent. The aim of this research was to provide insight into the reasons why these students had engaged. It is clear from the interviews that these students experienced mathematical difficulties in their first year; however they all had a plan or coping mechanism to help them succeed. They regularly mentioned social interactions with students and staff members. Consequently the main focus of this paper is to examine these social interactions and how they formed part of the students' coping mechanisms. These interactions can be broken into two categories: interactions with teaching staff; and interactions with friends and peers. When negative experiences are related by the students we note that they always find a way to engage with other supports available.*

## INTRODUCTION

The Department of Mathematics and Statistics at the National University of Ireland Maynooth (NUIM) has many supports in place to help students if they experience difficulties. In addition to lectures, each student is assigned to a weekly small-group tutorial where attendance is taken and students also have homework graded every week. Online courses and additional workshops have been designed to help students with weak mathematical backgrounds, and the department runs a very successful Mathematics Support Centre (MSC). For the remainder of this paper when we mention mathematics supports we mean all the services mentioned here. The main service of the MSC is the drop in centre where students can seek help with any mathematics related problem. The MSC operates in an informal and friendly atmosphere, encouraging the students not to be fearful or embarrassed to attend and seek help. The engagement level of students with the available supports varies and consequently we decided to investigate the reasons and motivations why certain students engage with mathematics supports and others do not.

In September 2009 seven students, who were repeating their first year of mathematics, were interviewed and it subsequently emerged that they had not generally engaged with mathematics supports. The dominant theme to emerge from these interviews was the embarrassment and fear suffered by these students (Grehan, Mac an Bhaird, & O'Shea, 2010, 2011). Four different facets of fear were identified: fear of failure; fear of showing a lack of knowledge or ability; fear of being singled out; and fear of the unknown. Other factors identified in our study as important in students' non-engagement with mathematics support included: the demoralising effect of failing first semester examinations; the anonymity of large classes; and to a lesser extent the lack of awareness of support services. Very few of these students mentioned working on mathematics with their friends or peers and very rarely discussed interactions with lecturers or tutors. Analysis of these interviews showed that the

students who did not avail of supports were often not aware that they had a problem, or were unwilling to admit to it (to themselves or others) until it was too late.

To obtain further insight into the reasons students engage or do not engage with mathematics supports we decided to conduct interviews with students with similar mathematical backgrounds to the first group, but who had generally engaged with mathematics supports. These interviews took place in spring 2010. Ten students were chosen at random and nine were interviewed. Preliminary results (Grehan, Mac an Bhaird, & O'Shea, to appear) have shown that these students encounter many of the same difficulties as the first group. However, the majority have some plan or strategy to overcome these difficulties. Other factors that emerged as significant in promoting engagement were: personal motivation; the willingness to admit to having problems; the appreciation of mathematics as a cumulative subject; and social interactions between students and peers and staff. Analysis of all of these factors is ongoing but these social interactions and relationships form the main focus of this paper.

In contrast to the first group, these students frequently mentioned interactions with peers and staff. Many of them had discussed mathematics with their friends and classmates. Most mentioned working in groups to solve problems or tackle assignments. Some negative experiences are also related but we will see how these students found some alternative way to engage with mathematical support in these situations.

## **LITERATURE REVIEW**

Several studies have shown the positive impacts of students engaging with mathematics, and specifically with mathematics support. In a paper by colleagues at NUIM (Mac an Bhaird, Morgan, & O'Shea, 2009) it was shown that the MSC has a positive effect on the grades of students who attend. It is of interest that mathematics support is particularly beneficial to those with a weak mathematical background. However, many at-risk students do not avail of mathematics support. Similar studies by Dowling and Nolan (2006) and Pell and Croft (2008) discuss the benefits of students engaging with mathematics support but also reinforce the findings that it is not always the students most in need of support who attend the MSC.

Similar results were found during an investigation by Symonds (2008) at Loughborough University in the UK. She interviewed a small number of students and found that there was a very strong correlation between engagement with mathematics and a student's mathematics module grade.

A separate paper by Mac an Bhaird and O'Shea (2009) suggests that students deemed at risk in first year are more likely to engage than those not deemed at risk. This study took place in NUIM and is especially relevant to our ongoing research. The authors admit that the statistics do not shed light on the reasons behind the lack of engagement of some students.

The study carried out by Symonds (2008) suggests that a lack of awareness of the location of services and a lack of awareness of the facilities and supports available to them form part of the reason students do not engage with mathematics support. However, she openly questions whether these are the real reasons for non-engagement and suggests that students who



regularly engage overcome these issues with a lack of awareness of location and supports available:

Such students were able to overcome these barriers in order to avail themselves of the support facilities. This poses the question: would simply implementing the above suggestions (advertising, actively seeking out students who need help, staff changes) be enough to improve the uptake of support amongst failing students? (P.140)

Other authors have found that the fear of showing a lack of knowledge or ability negatively impacts on students' willingness to ask questions (Ryan, Pintrich, & Midgley, 2001). They explore why students do not ask for help:

Students who feel insecure about their abilities-academically or relating socially to other students-are more likely to avoid help seeking. Students who are focused on their reputation-academic or social-are more likely to avoid help seeking. (P.110-111)

This suggests that students' goals can play a role in students' choice to seek help. Early work in this area includes papers by Dweck (1986) and Pintrich (1994). Goal theory, until quite recently, was limited to the idea of performance and mastery goals. Students with mastery goals were understood to be motivated by a desire to understand a topic in depth and increase their knowledge and understanding, whereas students with performance goals were understood to be motivated by the desire to do well in examinations and other extrinsic factors. However, psychologists have recently suggested that these definitions are an oversimplification. Research from Dowson and McInerney (2003) and Levy, Kaplan and Patrick (2004) highlighted their independent discovery of several social goal orientations. These orientations cover varying ideas such as sense of belonging to a group; desire to receive praise from peers or teachers, and wanting to assist others with their academic and personal development.

Hannula (2006) has studied in detail the social aspect of student motivation. He believes that one of the primary facets of how students are motivated is the psychological need for social belonging. He discusses the possibility that students are motivated by goals such as wanting to contribute to group project work and affected by the social norms of the classroom environment. He showed how some students' choices were being dominated by social goals.

In a recent paper from researchers at Loughborough (Inglis, Palipana, Trenholm, & Ward, to appear) it was found that students who attend lectures and the MSC have higher levels of attainment than those who do not. One of the reasons suggested in this paper is the face-to-face interaction in lectures and the MSC as compared to online learning supports. The social perspective on learning was highlighted by Lave and Wenger (1991) when they introduced the concept of 'communities of practice'. Wenger (2004) defines this as follows:

'communities of practices are groups of people who share a concern or passion for something they do and learn how to do it better by interacting regularly', (p. 1). In their view, learning is a social activity which takes place within a community and is facilitated by the sharing of ideas and understanding both between teachers and students and between peers. They see learning as a form of apprenticeship where students learn both from the practices of experts and by taking part in meaningful activities in the field. These studies show that social goals

and interactions can have an effect on engagement. It is this effect that we will explore in the remainder of this paper.

## **METHODOLOGY**

In September 2009 we decided to investigate the reasons behind non-engagement with mathematics supports. We began by conducting an analysis of the engagement of students who had failed first year mathematics. Subsequently we randomly selected students who had similar mathematical backgrounds to students in the first group but who had passed first year examinations and had engaged with mathematics supports. Similar mathematical background is determined by two categories: Leaving Certificate mathematics result; and the result of a diagnostic test at the beginning of the first semester. We interviewed nine of these students.

All the interviews were conducted by the first author. Each interview lasted for approximately forty minutes. The questions were open-ended and concerned the students' mathematical education prior to enrolling in NUIM, their impression of mathematics at university, and their views on the mathematics support available to them and their reasons for engaging or not engaging with mathematics supports.

The interviews were transcribed by the first author. The transcripts had all identifying characteristics of the interviewees removed prior to coding. The transcriptions were coded separately by the three authors using Grounded Theory. The methods for analysing qualitative data using Grounded Theory are laid down by Strauss and Corbin (1998). They emphasise how to utilise one's personal and professional experience to allow you insight ("sensitivity") into the data but also caution against the bias that these experiences naturally lend to the process. Both cohorts of students frequently commented on the specific details of their mathematical experiences in NUIM. On these occasions, the three authors utilised their knowledge of the structure of mathematics support at NUIM to interpret the students' comments.

The codes were compared and contrasted, and from this process concepts and categories emerged from the data. This process and the categories that emerged from both sets of interviews are discussed in Grehan et al., (2010, 2011, to appear).

## **RESULTS**

The main focus of this paper is to examine the social interactions and relationships mentioned by the second group of students during the course of their interviews. These interactions can be broken into two categories: interactions with teaching staff; and interactions with friends and peers. Although these students frequently mentioned difficulties, unlike our first group they were rarely deterred by these negative experiences; they almost always found some other way to engage with the supports available. We argue that these social interactions and relationships are part of the coping mechanisms that they use to succeed.

Data from our first group (Grehan et al., 2010, 2011, to appear) showed that those students rarely mentioned social interactions in relation to mathematics. This second group mention such interactions regularly. They also refer to social interactions with teachers, peers and



parents at second level but we will focus purely on their experiences at third level in this paper.

### **Relationships/Interactions with Teaching Staff**

In contrast to the first group, it is clear from our interviews that these students place high value on their interactions with lecturers, tutors and MSC support staff. While most interactions with staff are positive we will also see that negative experiences do occur. The first group of students had difficulties with all of the mathematical supports on offer including lectures, tutorials and assignments. The second group generally compensated for a difficulty with one of these supports by attending or seeking help at another.

Students were asked to comment on the importance of lectures and commented frequently about the interactions they had with lecturing staff. Several students discussed how approachable they perceived their lecturers to be and how at ease this put them. Adrian mentioned several times how he viewed the teacher-student relationship as more like a friendship than a formal relationship:

The attitude that they have, not just with the mathematical content, but teachers in general in college, it's a much more mature relationship. I mean, it's more like a conversation between friends, that's how I perceive it like.

Other students commented on how they found some lecturers intimidating and unapproachable. Class size was mentioned by some as a contributing factor to the view that one could not ask a question in a lecture. Students admitted to being too embarrassed to ask questions in large classes and suggested that this may be part of the reason lecturers appear to be unapproachable. Janice talks about her view of mathematics lecturers as being intimidating:

Well I got help, the only people I didn't go to were the lecturers. They were the only ones, in 1<sup>st</sup> year I would have found slightly intimidating, now this year I have no problems going to my lecturers. I would have been slightly intimidated going to them last year but I went to everyone else and I had no problem sticking up my hand and saying I don't get that!

It should be noted that Janice is no longer studying maths and the lecturers she now feels comfortable in approaching are from other departments. She clearly says that although she found her lecturers intimidating that she went to "everyone else" and had no issue asking them for help. As we will see later, Janice regularly attended the MSC and sought help from her friends. A negative experience did not dissuade her from availing of other aspects of mathematics support.

For many students, a perception that the lecturer or tutor wanted to help them seemed to influence their level of engagement. Adrian said that he was nervous about studying mathematics at university but that the attitudes of the staff he encountered encouraged him:

You feel like it's somebody who really wants you to learn rather than somebody who is kind of spitting at you. .... Em, what was different? (The lecturer's) attitude really and the fact I really felt they wanted you to understand things.

Aoife expresses a similar sentiment when talking about the atmosphere in tutorials and her tutor:

You knew that you were being watched, not even that you were watched, that you were being helped. And there was someone you could go and talk to about certain problems.... My tutor...he was, I found him really good, he wasn't real pushy or annoying, he was kinda like "ah you'll be grand" kind of thing but you could tell he would actually help you. I know he sound a bit blasé but he'd always come over and help you know that kind of way? I just felt more at ease.

Students also commented on the MSC tutors and their interactions with them. The majority of students were highly positive about these interactions and several commented on how the tutors were like friends who would help with mathematical problems. David says:

I think the biggest thing about the MSC is the psychological effect. To know that somebody will help you, for me that was the biggest thing. It also, it tied in with the atmosphere that I had of the teacher wanting you to understand things and more like your friend explaining something to you rather than somebody just spouting the information.

A common facet of students' unwillingness to interact or seek help from lecturers was their perception that office hours were not for "normal" students, or that lecturers do not really want students to use them. Here Shane explains:

They always seemed really busy and like, I know they have office hours and stuff but I was always like, that's for proper problems, not for a problem with your assignment...like (you would be) putting them out by going to them.

Commenting again on office hours Shane adds:

I know they just have to put it up there, but I wouldn't see it as something they want you doing.

Shane eventually stopped attending mathematics lectures due to feeling he was not getting anything out of the classes. However, he would take his borrowed lecture notes and his assignments to the MSC and seek help there. This is another example of a negative experience not preventing a student from engaging with another form of mathematical support.

Students commented in depth about their interactions and relationships with their tutors. Many of the students spoke about tutors' attitudes to questions. Here Janice speaks about the one to one support she received in the MSC:

You felt you could ask and the fact that they never laughed at you. Cause that's the big fear asking a question that they're gonna turn round and laugh at you and none of them ever looked at you to say you're stupid.

Aoife comments that the attitudes of the tutors in the MSC made it easier for her to go and to ask questions:

And you were talked to like you were an adult, you were never talked down to. No matter how stupid the question was or how small or how large, you were always helped, you were never kinda put down.



Students also reported that they felt more at ease asking tutors for help rather than lecturers because they feel closer in age and experience to them. Janice says:

You'd be afraid to go to a lecturer, they're doing this for ages and they've got their PhDs. ... (tutors) have just gone through the college thing and I'm sure they didn't find it a dross the whole way through. So you think they might at least think to themselves, 'OK, well I kind of understand where she's coming from'.

Some students commented on the negative aspects of engaging with tutors. Siobhán found interacting with her tutor difficult and was too intimidated or embarrassed to engage in the class:

Everyone was too afraid to speak when he asked a question. And it, awww, it was just an hour of silence!

Siobhán may have been too embarrassed to engage in tutorials but she overcame this difficulty by regularly attending the MSC where she had no issue with asking for help from the tutors.

Again negative experiences were not a major setback to these students. When confronted by an MSC staff member with whom he did not interact well, Shane developed "favourites", tutors he knew were a good fit for him. These students were all aware of their own learning style and that links into knowing what tutors worked best for them. Shane states:

I suppose you get to know the tutors in there and you'd know who to go to, you know who'd be better for you.

It is clear from the evidence above that these students value their interactions with staff members. Students detail the personal interactions and relationships they have with their lecturers and tutors and it is apparent that their engagement with mathematics supports is affected by those relationships. They use these relationships to help themselves cope with their difficulties with mathematics. It is clear from the majority of comments mentioned by students that a positive interaction with lecturers or tutors encouraged students to ask for help, made them more comfortable and less likely to be embarrassed or afraid. We note that even if these students had negative experiences with a staff member they still engaged somehow. They may have altered their engagement, stopped attending lectures or tutorials perhaps, but they compensated elsewhere, studying with friends, in the MSC, or studying independently.

### **Influence of Friends/Peers on Engagement**

Whilst the second group of students were selected because they engaged with mathematics support it emerged that the influence and experiences of peers and classmates were vital in determining the shape and form of that engagement. One of the main differences between this cohort of students and the first group was the formers' apparent willingness to work on mathematics with their friends and classmates. The first group of students rarely mentioned interactions with friends or peers in relation to mathematics. They were also reluctant to admit to themselves or others that they were struggling with mathematics and it is possible that this was a contributing factor to the lack of social interactions related by them during their interviews. As we shall see the second group rarely had such issues.

Each student had some negative experiences with regards to their interactions with friends and peers but we will outline how they altered their engagement so as to get help another way. We will again attempt to portray how these interactions and cooperation with their peers formed part of a general strategy aimed at helping themselves cope with their difficulties with mathematics.

Working with others on mathematics generally took two forms: working in groups in the MSC and meeting with friends or peers outside of class to work together. When questioned about the positives and negatives of group work it was apparent that most of these students were quite aware of their own learning style, as touched upon above. It was clear they had thought about how working in groups helps or hinders them in respect to completing their mathematics assignments.

Several students mentioned deciding to attend the MSC based on recommendations from friends. Aoife specifically mentions how she had a negative reaction when she heard about the MSC in a lecture but how a recommendation from peers swayed her into attending for the first time:

But one of the girls who lived downstairs, you know we'd go to lectures together. And she was living with two other girls who (did) 3<sup>rd</sup> or 4<sup>th</sup> year maths and they were telling us how helpful the MSC was. You know when you hear about something and you're like 'ugh'. But then the second week we went and it was such a lifeline like.

Again we see how negative experiences or perceptions are not critical setbacks for these students. Shane, who later became a regular attendee, expressed similar reservations before attending based on a friend's recommendation:

Well I wasn't sure about it now, I didn't think, maybe how popular it'd be. So I thought, you know, if I go in maybe I'll be the only one in there.

When questioned about group work in the MSC, students mentioned how beneficial it was to be able to discuss ideas with peers. They also noted how working in groups left them more independent of the MSC tutors, and remarked on the sense of team work that built up from working on problems together. Jason says:

I found group work the best. I dunno, you could just ask somebody, bounce an idea off somebody or somebody would ask you, "what do you think?" and you're less reliant on the tutors as well then.

They also spoke about the benefits of learning from peers rather than teachers. Sorcha says:

It was just, like one of you knew the first step, the other knew the other step, it was easier to explain to each other rather than having a lecturer or someone trying to explain it to you where it's like impossible!

Several of these students stated the unease and embarrassment they had with asking questions in the MSC when working by themselves, and how working in a group helped negate that fear. Lisa says:



I'd feel a bit more shy cause you feel like you're the only one yourself saying "I don't know that". Where there's obviously a few of you (in a group) saying we all don't know.

Not all students were comfortable participating in group work in the MSC however. A common worry about working with peers in the MSC was that of embarrassment. Janice says:

Well just the whole you don't want to stick up your hand cause you'd feel embarrassed if you were keeping everyone back.

As we will see below Janice was not deterred by her fear of working in a group in the MSC and found help from her friends.

Group work was not confined to the MSC. Adrian discusses how he and some friends would get together and do some mathematics:

Group work, if I'm working on my own project I like it if I'm working with somebody who I feel is working back with me. Sometimes after one of the maths classes the schedule is convenient for Callan Hall (lecture theatre), myself (and two others) we work together and we solve things on our own and it is great.

Janice also worked a lot on mathematics outside the MSC. Her hours as a first science student meant it was difficult for her to attend the MSC. A lot of first science students experience this difficulty but this did not prevent Janice from seeking help elsewhere. She managed to find a group of friends to help her with her assignments. She mentions this help several times through her interview and it is clear she feels it had a big impact on her engagement and final grade:

Every week about five of us got round the table, one was an expert at maths, the other was good at maths, between the two of them they'd work it out and then they'd help me and a couple of the others who were really struggling... To be honest I don't think I'd have passed if I hadn't (gotten help from friends).

We have detailed both the positive and negative influences of interactions with peers and classmates. We have seen that students were not afraid to admit to themselves or others that they were struggling with mathematics and it is apparent that working with peers or classmates on mathematics was an important aspect of this characteristic behaviour. Again it is clear that the majority of these students feel comfortable doing mathematics with their peers. Some took advice on what type of support works and others mention the reassurance of working in groups where they feel everyone has the same difficulties. They often feel more comfortable asking questions in a group rather than as an individual. Although negative experiences occur and negative perceptions exist, these students alter their type of engagement to make sure they get help with their difficulties. It is also apparent that immersing themselves in group work is part of a coping mechanism to allow them to deal with their difficulties with mathematics.

## **CONCLUSION**

In this paper we focussed on the influence of social interactions on students' engagement with mathematics. It emerged from our analysis that students who engage encounter many of the

same difficulties as non-engaging students (Grehan et al., 2010, 2011, to appear), in particular they had to grapple with fear and embarrassment. Other authors (Hannula, 2006, Ryan et al., 2001) have shown how embarrassment can affect a student's willingness to ask questions and affect their engagement with mathematics. However, few of our engaging students were deeply affected by the difficulties they encountered and further investigation of this issue is required. For example, we could consider how "resilient" these students are to setbacks (Williams, 2003). We have detailed how the two types of interactions, with teaching staff or peers, were used as part of a general strategy to overcome the variety of difficulties with mathematics.

Most of the students who participated in this study had positive experiences with tutors and to a lesser extent with lecturers. It is clear that students highly value the interactions and relationships they have with teaching staff and that they form part of the coping mechanisms discussed above. This is consistent with Inglis et al. (to appear) who highlighted the importance of face-to-face interactions in lectures and the MSC and found a link between those who attended and their attainment. Our first group of interviewees rarely had the benefit of such interactions whereas the second group listed numerous examples of the face-to-face interactions that Inglis et al. (to appear) discuss. In particular many students in this group speak of the importance of feeling that a lecturer or tutor wants to help, and of the kind of relationship they had with their lecturer or tutor. They seem to suggest that a friendly atmosphere in classes and a mature relationship with their teachers encourages them to want to understand and to seek help when needed.

All interviewees in the second group were involved in working with and interacting with peers in relation to mathematics. Many visited the MSC with friends or on the recommendation of a friend. All nine students used group work at some point in the year. For some it was a way of dealing with the fear of asking a question, a 'safety in numbers' strategy, while for others it was a means of getting help outside the MSC. It was obviously also a way of learning from peers and we can see shades of Lave and Wenger's (1991) communities of practice when students comment on working in groups. However, we did not explicitly see many of the social goal orientations explored by Dowson and McInerney (2003) but a further study as detailed below may shed more light on this issue.

The issue of why these students engage is clearly a complex one. It is apparent that the positive experiences of the second group detailed above contributed to a positive learning experience. The first group rarely speak about their experience of mathematics in a positive light. Furthermore we have only considered the social aspect of their engagement for this paper. Other features such as their motivations, their goals and their willingness to admit to having difficulties are equally as important. We have completed interviews with twenty five additional students and a full analysis of all three cohorts will be required to gain a deeper understanding of these issues. We have also amended the interview structure to include additional questions on student motivations and goal orientations.



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