

The Necessity of Maths Support Centres in Higher Level Education.

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Abstract:

There is a crisis in Maths Education in this country. One reflection of this is the huge numbers of secondary school students who pass state exams, yet still display alarming weaknesses in basic mathematical manipulations and understanding. The weaknesses are very obvious when these students continue on to third-level education. Even if students can apply a method, they generally do not understand exactly what they are doing. As a result of these problems, students lack the confidence or courage to tackle any new material. They are reluctant to discuss Mathematics, and they often do not understand why they are struggling. One step third-level institutes are taking to combat this problem is to establish Mathematics Support Centres. I will use the Maths Support Centre (MSC) in the National University of Ireland (NUIM) as a case study to discuss the impact of such facilities on the student learning experience.

1. Introduction:

A recent audit completed by the Regional Centre for Excellence in Mathematics Teaching and Learning (CEMTL) in the University of Limerick [2] has collected reports completed by all Maths support facilities in Ireland. It gives a useful insight into the current facilities and services available. These services will be described in some detail in this paper. Most support centres produce annual reports, which contain additional relevant information, see [6], [13] and [16].

The development of Maths support in the UK has a longer and more successful history. Their facilities and services are state-of-the-art and something that we should all aspire to. The centres in the universities of Loughborough and Coventry are worth particular mention, as well as the impressive online facilities, see www.mathcentre.ac.uk. There are several studies available on their extensive Maths support system, see [20], and [21]. Before we can properly investigate the effectiveness of and necessity for Maths support, it is important to look at some of the reasons why third-level institutions are introducing Maths support on a wide scale. Some of the reasons are discussed in [9]. We will discuss these issues briefly in section 2.

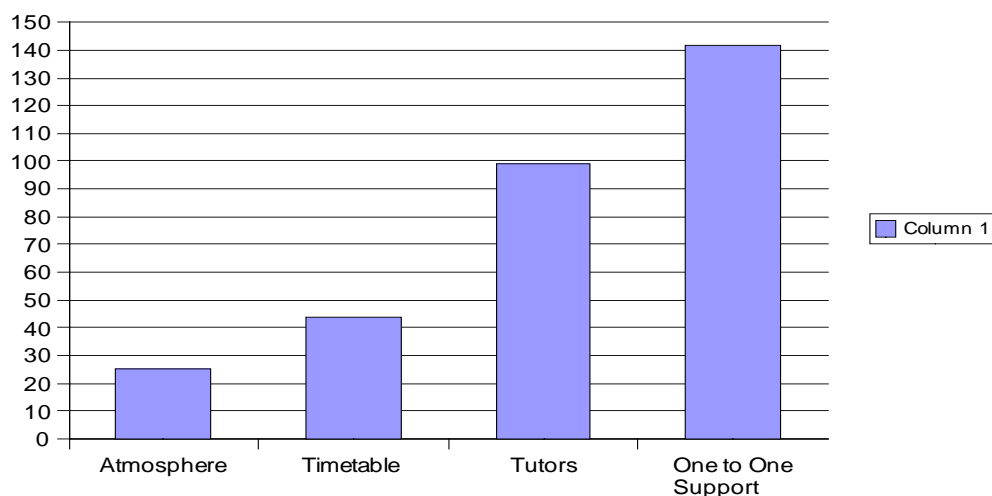
The effectiveness of Maths support is difficult to quantify. I will discuss this in section 3. Many of the arguments and examples throughout the paper result from extensive analysis of the data collected and compiled by the MSC in NUIM. This data covers all aspects of the MSC and also considers new teaching technologies that the MSC is using. All Maths students in NUIM were given a questionnaire during the last week of the second semester. Of the 358 that were completed and returned, 211 were from students who had attended the MSC. Much of the data contained in this paper comes from the questionnaire. The services provided are similar in outlook and direction to other support centres in Ireland; see [2], [6] and [16].

2. The widespread introduction of Maths support and some of the services provided.

Maths support (outside of normal lectures and tutorials) is officially available at university level in DCU, NUIM, UCD and UL. It is also available in CIT, IT Carlow, DIT, IT Tallaght, IT Blanchardstown, LIT, IT Tralee, IT Letterkenny and Mary Immaculate College, Limerick. For a detailed report on the services provided by each of these, see [2]. There are a wide range of support services available in each centre; these are usually dependent on the facilities and funding available, as well as the dedication of members of staff. The most common type of support is the provision of drop-in sessions where one-to-one help is provided.

Obtaining sufficient and permanent funding is essential for the success of any support centre. Several institutions including UL and DCU have secured permanent or long-term funding. The high standard of their centres is a reflection of the funding available and their dedication to providing excellent facilities and services. The main expenditure is on staff wages, but having experienced and friendly tutors is essential. They provide the expert one-to-one support, and they help generate a friendly and non-judgemental atmosphere, see figure 1. Students in NUIM were given a questionnaire and asked to list what they thought were the best aspects of the MSC. The majority of the responses came under the following headings: one-to-one support, tutors, timetable and the atmosphere created.

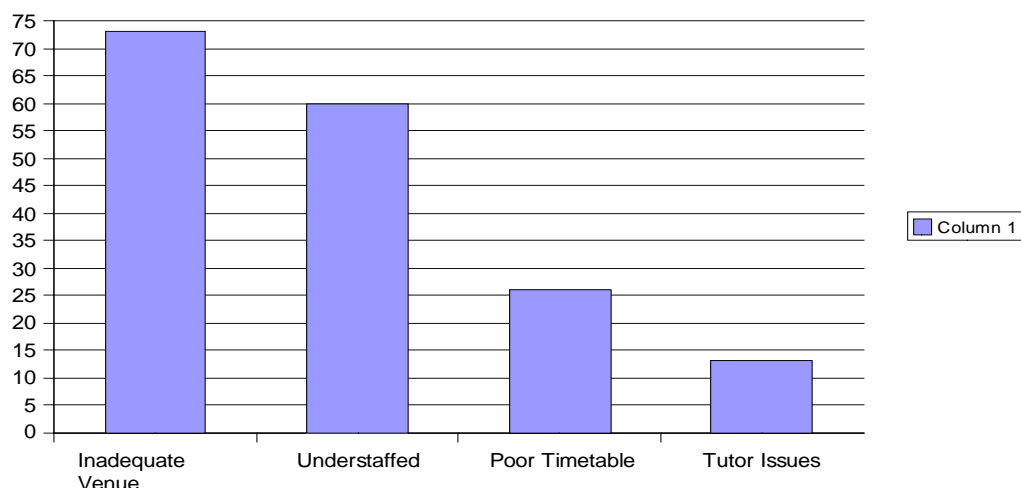
Figure 1: Students' opinions on good aspects of the MSC.



The MSC in NUIM was particularly busy in its first year with an average of over 125 visits per week. The centre opened in September 2007 (a smaller centre was open briefly in 2004) and feedback from students and staff has been very positive, see [13]. However, due to high student attendance, the service provided in the one-to-one sessions is restricted by inadequate facilities (the venue is also used for lectures and tutorials) and low staffing levels. Insufficient funding impacts on all Maths support services. Of particular concern is the number of tutors available to offer one-to-one support, and this in turn affects the amount of one-to-one help an individual student will receive. In figure 2 only students who attended the MSC were asked to list aspects of the MSC they found unsatisfactory. The majority of the responses came

under the following headings: inadequate venue, understaffed, poor timetable and tutor related issues. The tutor related issues were investigated further, but the majority of these responses involved students stating that they were not getting enough attention from particular tutors. This was typically due to the overcrowding and understaffing issues.

Figure 2: Students' opinion on bad aspects of the MSC.



Drop-in sessions in support centres are usually supplemented by web- and paper-based resources which are extensively used by the students. Some centres provide other classes which deal with specific issues that arise in the sessions or common problems that are reported by lecturers and tutors. Some of these additional facilities are mentioned in section 3.

2. Why is Maths support being introduced at third-level?

Maths support has been introduced in most universities and institutes of technology within the past ten to fifteen years. This is in response to the clear decline in basic skills and knowledge amongst incoming students and the knock on effects. In [9], the authors discuss some of the details of the problems that are apparent at third-level. They state '*...the inability of students to successfully make the transition to tertiary level mathematics education lies in the substantial mismatch between the nature of entrants' pre-tertiary mathematical experiences and subsequent tertiary level mathematics-intensive courses.*'

In NUIM, the decline in basic abilities is very evident from the diagnostic tests that are issued to first year students. This is not a new phenomenon, see [10] and [23] for details of similar tests. These tests cover basic problems in symbol manipulation, algebra and geometry, as well as some calculus. All of this material is on the curriculum at second-level and is not considered advanced. The failure rates (incoming students 2007-2008) are high considering the level of the test, 16.8% in First Arts/Finance and 37% in First Science. In DCU a similar diagnostic testing system is used, and students who get below a certain grade are pointed in the direction of Maths support [16]. Many other third-level institutes issue similar tests and the results are also quite low, see [8].

Recent reports have expressed concern with the mathematical competences of Irish students at second level [15]. Low attainment in Mathematics is often cited as a

contributing factor in low enrolment and retention rates in science and technology courses (Task Force on the Physical Sciences, 2002) and [17]. In [12], (and to a lesser extent in [15]) a detailed analysis of the teaching and learning of Maths at second level is made. It is clearly a very complex situation. It is not the purpose of this paper to debate the issues. However, some of the main factors listed in [12] and elsewhere include bad publicity for Maths, negative attitudes towards the subject, the high percentage of second-level students who go onto third-level, the socio-economic background of the student, increased competition for places, pressure on students and teachers to achieve the highest possible points, little understanding of the context or background of Maths, little appreciation of the applications of Maths in everyday life, rote learning by heart, etc. Several significant studies have highlighted possible impacts of these problems; see [4], [7] and [12]. In [12], the authors, who conducted a comprehensive case study of ten secondary schools, state that *'...most of the students did not have the necessary vocabulary to discuss Maths as a subject and had little interest in discussing it.'*

These problems are not confined to Ireland. An international report [22] highlights the bad image that students have of Maths; it mentions that mathematicians are largely invisible to lower secondary school students, and that students hold very stereotyped and negative views of Mathematics.

Introducing new teaching methods is a priority. A main cause of concern is that most mathematical teaching at second-level appears to promote rote learning instead of creating an understanding of the material, as well as discussing its context and background, see [9] and [12]. There is also little concentration on the everyday applications of Maths. Attempts have been made by the Department of Education to address these issues by introducing new syllabi and providing guidelines for teachers. However, because of the time pressures on teachers to complete the current syllabi, it is very difficult for them to change their teaching methods. *'...in-service provision has encouraged and supported teachers to adopt a wider variety of teaching methodologies. Although 'teaching for understanding' is a focus of such training, it is not clear to what extent novel methodologies are used in the classroom.'* [4]. The Irish school year is also shorter than the international norm, there are fewer teaching weeks in the year and fewer teaching hours in the day, see [12] and [18]. This is coupled with the fact that we do not specialise in one or two subjects, consequently there is much less time available for each subject. So, in effect, there is little incentive or time available for teachers to consider alternative teaching approaches.

Changes in the approach to Maths education are essential, but they must be carefully considered before introduction. In [12], some evidence of success in primary schools is mentioned upon the introduction of a new syllabus. Studies have reported an increased understanding and enjoyment of Maths by students. The discussion for the causes in the decline of abilities and basic skills is a very important one. It needs to be considered at a national (and international) level with co-operation between people involved and interested in all levels of Maths education. A concerted and combined approach is required urgently. Simply saying that the syllabus will be changed without taking other factors into consideration is not sufficient. A common consensus on the causes must be reached and the appropriate measures taken.

3. The necessity for and benefits of Maths support.

The benefits of Maths support can be very hard to quantify. The fact that Maths support centres are now so prevalent in Ireland and the UK shows that there is certainly a demand for their services. However, this might be a reflection of the

increasing number of difficulties that students are having. In the audits and reports of support centres that are available, attendance figures and codes of practice are usually covered. For the most part they refer to the attendance rates at drop-in sessions and the numbers of students accessing other services. The statistics are very impressive, but is it clear that the students are benefiting? There are a number of papers from the UK that discuss how to analyse the impacts of Maths support, see [11] and [19]. I will use the evidence and statistics collected from the MSC in NUIM as an indicator of the benefits that Maths support can have on student learning and understanding of Maths in Ireland.

It is important to note that no major conclusions can be taken from one year of operation and research. However, the initial signs are encouraging and students who attended the MSC have consistently higher grades than students who did not attend. Table 1 lists the differences between first Science students who have attended the MSC and those who have not. It also lists their Leaving Certificate grades in Maths. It is clear that the MSC is having a significant impact on the weaker students.

Table 1: A list of first year students' leaving cert grade, and a comparison of their end of year marks, comparing those you attended the MSC with those who did not.

Leaving Cert. Grade Group	Mean Mark of students who visited the MSC more than once	Number of Students	Mean Mark of students who visited the MSC once or less	Number of Students
HA	-	0	761.00	5
HB	752.25	4	730.92	25
HC	719.75	4	635.64	28
HD	654.00	1	567.47	17
OA	547.56	9	511.84	37
OB	450.00	19	381.86	36
OC	320.00	5	288.87	15
OD	510.00	1	302.17	6

This information alone does not prove an increased understanding and command of basic skills. However, when coupled with the feedback obtained from the 358 completed questionnaires in NUIM, there is every reason to be positive about the benefits that Maths support provides. A detailed analysis of the student feedback can be found in [13]; however we will present some of the relevant information here. Unless indicated otherwise, the questions listed are addressed to both students who attended the MSC and students who did not.

The students were asked if they would consider dropping Maths courses because of difficulties with Maths. 335 answered this question, (144) 43% said yes and 57% said no. Students who answered yes, were also asked if the MSC had influenced their decision to retain Maths as a university subject. 125 out of the 144 answered this question, (43) 34.4% said yes and 65.6% said no. It is encouraging that Maths support appears to have an impact on a student's decision to continue with Maths as a subject. However, a more detailed analysis is required. Many of the students who answered no indicated that they had no choice in the matter. They either had to do Maths as part of their degree or they had to drop it after so many years.

The students were asked if they considered leaving university because of difficulties with their Mathematics. 338 answered this question, (52) 15.4% said yes and 84.6% said no. Students who answered yes, were also asked if the MSC had influenced their decision to remain in university. 48 out of the 52 answered, (20)

41.7% said yes and 58.3 % said no. Maths support is clearly having a significant impact, particularly on students who struggle with Maths. It has helped students who may have left higher level education because of mathematical difficulties to remain in third-level education. It is also influencing some students to retain Maths as one of their subjects. Students were asked if the MSC had increased their confidence in their Maths ability. 254 (students who attended the MSC and students who said they were influenced by friends who attended) answered this question, with 59.5% agreeing or strongly agreeing. Only 2.8% disagreed or strongly disagreed. These responses are very encouraging in terms of the goal of addressing student weaknesses in Maths. A complete description is available in [13].

Another important advantage that Maths support centres have over traditional teaching venues is a freedom in teaching methodologies. As mentioned earlier, teachers are under various pressures to get courses and material covered. This is true in all levels of education. In Maths support there is no such constraint, so this gives the added opportunity to embrace any and all methods that will improve the students learning experience. I believe it is essential that all centres rise to this challenge. The MSC in NUIM introduced several pilot schemes using new technologies while teaching Maths during Semester 2 (2007-2008) and they were all very successful. For a detailed analysis of these technologies, the technical issues involved and the potential benefits for students using reusable learning objects, see [14]. We give a brief overview here.

The first pilot involved the creation of screencasts which were posted online for students to access in their own time. The screencasts covered aspects of integration by substitution. The students were very positive about this innovation, 75% of those who filled out the feedback form strongly agreeing or agreeing that the screencast helped them to understand the material. 50% of the students indicated that an audio and visual demonstration was preferable to reading text and several students also commented that they could also pause 'the lesson' at anytime to take notes. The second pilot involved the creation of podcasts to supplement normal lecture and tutorial notes. The main podcast contained an overview of the material covered in a lecture course (Linear Algebra). The feedback from the students mainly consisted of comments. They generally said that it was more reassuring and easier to understand audio instructions than to read written ones, the following comment was typical: *'I found it extremely helpful as it confirmed what we had to look over for the exam. I also find I can focus and take in what is being said more easily when listening than when reading notes. I have to read over them again and again to understand it.'*

The final pilot used touch-screen technology (Symposium) in an all-class tutorial. This effectively replaced the use of the blackboard. The benefits were that the teacher would have prepared notes on the screen which he could then write on as the class progressed and save these notes on the text. He could also do examples on the screen which would be automatically saved and then posted online for easy student access. The material being covered included volumes of revolution, and sequences and series. These are two areas that students traditionally find very tough so it is very encouraging that students were so positive about this technology. Amongst several questions posed, the students were asked if they felt that the new teaching style enhanced and focused their learning. 51 students answered these questions. 81.1 % agreed or strongly agreed that the use of Symposium in their class had enhanced their learning of the material. 79.3% agreed or strongly agreed that it had focused their attention on the material. The students also highlighted that they

could listen and take notes during class without having to rush to write down all the material. They knew it would be available online later. For more analysis see [13].

4. Conclusions:

There are major problems in Maths education nationally and internationally. The causes and reasons are widely debated, researched and published. The long-term solution is also a subject of much debate, see [1], [3] and [12]. It is clear that a combination of efforts is required. Maths support is one very effective part of the solution. Maths support is helping third-level students who are struggling with various aspects of Maths to overcome their difficulties. There is evidence to show that Maths support is increasing student confidence in their Maths ability.

There is also evidence that attending informal MSC sessions is changing students' attitudes towards Maths. They no longer see a Maths learning environment as being so pressurised. There can be an atmosphere of fun and learning. These students are the future of the country and many of them will become teachers. If they leave university with a more positive attitude about Maths, an increased confidence in their ability and an exposure to alternative teaching approaches, then this will have an immeasurable impact on the Maths students of the future. Thus Maths support also plays a very important role in promoting the image on Maths to the general public

Maths support should be combined with a serious look at the Maths curriculum at all levels in Ireland. An invaluable contribution can be made to increasing the understanding and popularity of Maths. It should not be seen as an elitist or taboo subject, but something that anyone can understand to some degree if they have a command of the basic skills required.

5. Acknowledgements:

The author would like to thank Dr. Ann O'Shea and Professor Stephen Buckley for their constant enthusiasm, support and efforts on behalf on the MSC in NUIM. The MSC also relied heavily on the expertise of the tutors, their hard work and dedication is admirable. He would also like to thank all those already engaged in Maths support and education in Ireland and the UK who have given him invaluable advice and support. In particular, he thanks Dr. Eabhnat Ní Fhloinn and Dr. Olivia Gill.

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