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AN ANALYSIS OF MATHS LEARNING SUPPORT FOR MATURE STUDENTS IN ENGINEERING: ENGAGEMENT AND EFFECT.

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ABSTRACT: The Maths Learning Support Centre (MLSC) in the Dublin Institute of Technology (DIT) provides free mathematical support to all DIT students. This support is primarily delivered through a drop-in service, where students can receive one to one tuition in any area of mathematics. In the first semester of the 2013/14 academic year, a significant proportion of students enrolled in engineering programmes that availed of this drop-in service were mature students (approximately 42%) This is despite the fact that mature students constitute a relatively small proportion of the total student body (approximately 15%). This motivated the authors to examine the support offered to these students by the MLSC and also consider their attitudes towards this support. To this end focus groups were conducted in order to ascertain the attitudes of mature students in Engineering towards the MLSC. In addition some quantitative analysis was carried to determine what effect the MLSC had on student's academic performance.

Keywords: Mathematics education, mathematics learning support, mature students

INTRODUCTION

In recent years an increasing number of students in Irish Higher Educational Institutions (HEIs) are taking courses with mathematical and statistical elements. This is in part due to the widespread recognition that mathematics underpins many other disciplines (such as Science, Technology and Engineering) and the emphasis placed by the Higher Educational Authority on producing graduates who are highly literate in mathematics (EGFSN 2008, HEA 2004).

Hand in hand with this increase however has come the so called 'Maths Problem'- that is a decline in the mathematical proficiency of incoming first year students across HEIs in Ireland and elsewhere (Gill 2008, Almeida *et al*. 2012, Carr *et al.* 2013 & 2013). This in turn is having a detrimental effect on enrolment and retention levels in science and technology courses in HEIs (OECD 1999). In fact, it is widely acknowledged that the absence of a solid foundation in mathematics can be one of the key inhibitors for student progression in higher education (HEA 2008).

As part of the response to this problem, Maths Learning Support Centres (MLSCs), defined by Lawson *et al* (2003) as '*a facility offered to students (not necessarily of mathematics) which is in addition to their regular programme of teaching through lectures, tutorials, seminars, problems classes, personal tutorials, etc.'* have been set up in the majority of HEIs in Ireland (Gill *et al.* 2010). In the UK over 85% of HEIS surveyed offer some form of Maths Learning Support (MLS) (Perkin *et al.* 2012), up from 62.3 % in 2004 and 48% in 2001 (Perkin *et al.* 2004, Lawson *et al.* 2001). It is therefore clear that MLS has now become an integral part of the higher educational framework, both in Ireland and the UK.
However despite this, MLSCs in several HEIs exist precariously, often lack permanent funding and are regularly in the 'front line' for spending cut backs (Macgillivray *et al.* 2011, Mac an Bhaird *et al.* 2013). To ensure that the limited funding available for MLS is put to the best possible use and to establish 'Best Practice', much time

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and resources have been put into researching methods of evaluating MLSCs' activities. This evaluation can be undertaken using quantitative (usage figures, diagnostic testing, exam results etc.) and qualitative methods (focus groups, surveys, student feedback etc.) (Macgillivray *et al.* 2011). In a study on evaluation of the MLSC in Dublin City University, Ní Fhloinn found that a combination of both types of methods gave a more complete picture (Ní Fhloinn 2009). An extensive review of the literature on the evaluation of MLSCs can be found in (Matthews *et al.* 2012).

One important issue that arises from these evaluations is the non-engagement with MLS of so called 'at risk' students - those who are most in need of extra support. In a recent paper by Mac an Bhaird *et al.* (2013), details of a large scale study on student non-engagement with MLS across several Irish HEIs are given. The study found that the main reason students gave for non-engagement was that they did not need help. However this was more likely to have come from a student with a strong mathematical background. For the weaker 'at risk' students, issues with the structures of the MLS such as unsuitable opening hours or a lack of information were more likely to be cited as a reason for non-attendance. Symonds (2008) questions whether these reasons are valid and wonders if implementing the requested changes in structures would actually serve to increase the engagement levels of these students. This suggests that a deeper study into the reasons of student non-engagement with MLS, in particular for those 'at risk' students, is required to get to the root of the non-engagement problem.

In this paper, the authors seek to further this investigation by looking at the engagement levels of mature students with the MLSC in the Dublin Institute of Technology (DIT). In the DIT a mature student is defined as being '*any Irish or EU citizen who will be 23 years of age on the 1st of January of the proposed year of entry'* (DIT Website). The authors examine qualitatively the reasons behind both the engagement and non-engagement of this cohort of students with the MLSC, as well as performing a quantitative study on the effect of the MLSC on these students' academic performance.

METHODS

This study seeks to examine the reasons behind both the engagement and non-engagement of mature students with the MLSC in the DIT, as well as investigating how the MLSC has influenced the academic performance of mature students who have regularly availed of its services. The authors decided to use a mixed method approach by combining both quantitative and qualitative methods of research. Qualitative researchers are interested in understanding the meaning people have constructed from their lived experiences (Merriam, 2009). Hence, qualitative methods of enquiry and analysis are more suitable when humans are the instruments of enquiry. This is why the authors decided on a study of this nature. However, in order to evaluate the academic progress of mature students have been attending the Maths Support Centre a quantitative measure is needed. Much research supports this integration of quantitative and qualitative research. The use of multiple methods reflects an attempt to secure an in-depth understanding of the research and allows for broader and better results (Denzin and Lincoln, 2005).

Participants

The participants for this study comprised of mature students in their first year of an Engineering undergraduate programme in the DIT. As mentioned previously, in the DIT a mature student is defined as being '*any Irish or EU citizen who will be 23 years of age on the 1st of January of the proposed year of entry'.*

Qualitative Data

In order to get feedback regarding why students attend/do not attend the MLSC, two focus groups were conducted. The first group (Focus Group 1) was made up of mature students whose attendance in the MLSC was constant throughout the year. The second group (Focus Group 2) was made up of mature students who had never attended the MLSC. Each student was coded to ensure confidentially. There were ten students in Focus Group 1 (P1 – P10) and four students in Focus Group 2 (P11 – P14). Their responses were transcribed and analysed using NVivo software and arranged into themes by the authors.

Quantitative Data

In order to get a quantitative measure of how the MLSC influenced the academic performance of mature students who regularly availed of its services, the authors decided to compare the grades of mature students who attended the MLSC with those who didn't. The objective was to investigate if the MLSC had any effect on their grades. The authors understand that there may have been other variables which may have affected the students' grades throughout the year. The study focused on one particular group of students, who were undertaking their first year of an ordinary degree in mechanical engineering and compared the end of semseter exam results of those in this group who did and did not attend the MLSC in that semester. There were 20 mature students in this cohort. Of these students 8 had attended the MLSC and 12 had never attended.

RESULTS and FINDINGS

Focus Group Findings

In this section the main themes that arose during the focus groups are outlined. There will be particular focus on the two topics most relevant to this paper namely what motives mature students to attend the MLSC and the reasons given by these students for non-attendance.

Motivation

During the course of the focus group, it became clear that the motivations of mature students who attend the MLSC were multi-faceted. The initial motivations that were raised were of a practical nature, such as financial motivation (not being able to afford private tuition) or simply a lack of availability of any other form of support
P1: *I didn't even do a Junior Cert and I'm doing mechanical engineering maths and I've had straight A's through and that's through the Learning Centre you know. I can't afford grinds you know.*
P2: *There's no other, no other help available. That's what I found. If you're looking for extra help as well, every door would be closed.*

An interesting theme that arose was the concept that it was the nature of mathematics itself, and its difference from other subjects, which motivated students to seek extra help. They experienced difficulties with self-study and keeping up with the pace of lectures.
P1: *Whereas maths, you have something at the start of a page and something at the end and if you don't understand the bit in the middle, unless somebody points their finger at it and says to you "this is what's happening". If you don't get it you don't get it*.
P1: *I find with maths in particular of all the subjects.....Unless you get a hold of the stuff in September and you're doing October's work you haven't a hope, if you don't understand the basics of stuff you haven't a hope. So I found going to the learning centre each week, staying on top, learning whatever was current, you'd go in and you'd actually learn from the lecture as well.*

Related to this theme, some students stated that while they found self-study aids (such as textbooks or online mathematical resources) useful, it was their belief that these aids are not a replacement for one-to-one support, such as that offered in the MLSC.
P2: *They're all fairly good but you still need the one-on-one. Because you can keep pausing and rewinding and going backwards and forwards but you need the one-on-one....When you've got no basic level there's only so much a video or a book can teach you*

A widely held view among the participants was that the mature students' life experiences serve to motivate them to seek out the extra support offered by the MLSC.
P7: *because I'm guessing most of us have experienced what it's like to struggle through jobs and that kind of stuff and realise the importance of getting a decent qualification behind you and doing something you actually like.....*
P7: *it's that experience of having been at the bottom, you know and having to try and survive at the bottom, that you realise that when you get an opportunity like this, just how important it is to really avail of all the services, in my opinion the Maths Learning Centre being the most important that I've come across so far as an extra aid on top of your coursework and stuff like that.*

It is a stated aim of the MLSC (MLSC website) is to provide MLS to students in an informal, relaxed and non-judgemental manner. Such an environment enables the students to raise their confidence in mathematics and hence develop as independent learners. The responses of the focus groups show that this goal is being achieved.
P10: *You can ask the question three or four times say if you still don't get it, there's no kind of feeling embarrassed to keep on asking, they'll keep on explaining it to you until you actually understand what your actually doing so it is, it's a very relaxed environment so I find it very good that way.*

Finally, the participants noted that they are not just interested in passing the exams, but that they wish to gain a deeper understanding of the subject. They recognise, again possibly based upon their life experiences, the importance of possessing more than just a surface level knowledge of their chosen subject area.
P9: *but I want to be able to understand it you know, I want to be able to like if I go to a job interview and somebody puts a problem in front of me I want to be able to know what it's about…….I want to comprehend it basically and if I need that extra bit of support, which you do get in the Maths Support Centre then I'll take advantage of it.*

Reasons For Non-Engagement

This section outlines the main reasons given for the non-engagement of mature students with the MLSC. In a recent large scale survey on the issue of student non-engagement with MLS in Irish HEIs, it was found the main reason given by students who did not avail of service was that they did not believe they needed it (Mac an Bhaird *et al.* 2013). This finding was supported in our study.
P13*: I haven't really had a problem that I couldn't track down an answer to myself with google, youtube or any of that.*

Mac an Bhaird *et al* (2013) found that the second most common reason given for non-attendance were issues with the structural organisation of MLS in their HEI e.g. opening hours, room size etc. This theme also arose during our study.
P13*: if it was at a different time during the day that would suit me.*
P7*: I found that the only thing that kind of stopped me from going was the size of the room and at certain times because of how packed it is*
In Irish HEIs, several programmes are run to ease the transition of mature students back to education. During the focus groups, it was noted that mature students who have attended one of these transition programmes, appear to have less of a need for the services of the MLSC then those who have entered directly into their undergraduate programme.
P13: *Some mature students have a problem I think. Since they finished the LC and come back into college it has been 5-10 years. Not studied anything... I did last year mechanical engineering, this year I am ok.*
P11: *I wasn't too bad because I did Fetac 5 last year and it had engineering maths in it as well.*

Quantitative Findings

The study focused on one particular group of students, who were undertaking their first year of an ordinary degree in mechanical engineering and compared the end of semseter exam results of those in this group who did and did not attend the MLSC in that semester. There were 20 mature students in this cohort. Of these students 8 had attended the MLSC and 12 had never attended. Of the 8 students who attended, 2 dropped out of the course after the first few weeks so there was no data on their performance. For the 18 students who remained, theri performance in the semester 1 maths module was compared (See Table 1).

The average mark of those who attended the MLSC was higher but not significantly so ($p=0.25$). It is not possible to determine if the two groups were the same or different to begin with as many of these students are international students, and many of the Irish students had not finished secondary school. Hence there is no single metric to compare their mathematical ability on entry. There is a DIT mathematics diagnostic test given to many students on entry but it was not given to this cohort.

Table 1: A Comparsion Of End Of Semester Exam Results Of Those Who Did/Did Not Attend The MLSC.

Attended MLSC	N	Mean	Standard deviation
Yes	6	80.6	18.9
No	12	68.4	23

In addition, the proportion of the students who achieved a grade of more than 60% was examined (See Table 2). Using a two proportions test, there was a significant difference (p=0.046) between the students who attended the centre and those that did not.

Table 2: A Comparsion Of End Of Semester Exam Results Of Those Who Did/Did Not Attend The MLSC Who Achieved A Mark Higher Than 60%.

Attended Centre	N	>60	< 60
Yes	6	6	0
No	12	9	3

It is a limiation of this study that this analysis was only for a small number of students in one course. The two students who attended but dropped out early are excluded and and there is no metric for ranking the students on entry.

CONCLUSIONS

In this paper the authors investigated the reasons behind both the attendance and non-engagement of mature students with the MLSC in the DIT. Two focus groups were conducted with some interesting qualitative findings. The motivations of mature students were found to be multi-faceted, ranging from practical reasons, such as financial motivation, to more complex reasons such as their life experiences as adults motivating them to seek out extra help. The notion that mature students are interested not just in passing their exams, but also in gaining a deeper understanding of their chosen subjects was raised. The importance of one-to-one support in a student's development as an independent learner, even with the widespread availability of online resources, was also stressed.

For those students who did not avail of the services offered by the MLSC, the reasons given were mostly in line with the literature (Mac an Bhaird *et al* 2013), for example a lack of need for the service or issues with the structures of the MLSC. An interesting point raised was that mature students who have had a transition year prior to beginning their programme may have less need for extra support than those who have not attended such a course.

On the quantitative side, the authors examined the end of semester exam results of one group of students. They found that while the mean grade of those who attended the MLSC was higher than those who did not, the difference was not statistically significant (p=0.25). However when the results of those who got over 60% in the exam were compared, a significant difference (p=0.046) in the grades of those who attended compared to those who did not was found. These results must be viewed with a certain amount of caution however, as there was no common baseline for comparison of students' exams scores (e.g. diagnostic test results) and the sample size was small (18 students).

FUTURE WORK

The main question that arises when considering the positive engagement levels of mature students is why there are not similar engagement levels with traditional students. To investigate this further the authors intend to extend the work contained in this paper to include traditional students. The authors also wish to extend the quantitative analysis of this study to a much larger group of students as well as to benchmark students on entry using the DIT maths diagnostics test, in line with Carr *et al.* (2013).

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