Third-Level Specialised Support Centres
Their impact on student success

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Abstract

The Mathematics Support Centre (MSC) was opened in 2004 by the School of Mathematical Sciences, University College Dublin (UCD) to provide additional support to third level students with mathematical related issues. Motivated largely by the success of this centre, the Computer Science Support Centre (CPSC) was established by the UCD School of Computer Science and Informatics in September 2008, in order to provide a friendly atmosphere where students can voluntarily seek assistance with Computer Science (CS) related difficulties.

In this paper, we examine the ability of the MSC and the CPSC to support students who struggle with Mathematics and CS related difficulties at university. In particular, we compare the usage statistics of both centres. We also describe how students perceive the centres by examining and comparing their practices. In addition, we provide details about how the centres operate, focusing in particular on the services they provide to students and their resource usage. Finally, we examine the effectiveness of such centres in aiding students understanding of the fundamentals in CS and Mathematics.

Keywords

Third-level education, Support Centre, Mathematics, Computer Science

1. Introduction

The notion of establishing support centres originated in the mathematical domain, and was motivated by the well-documented decline in the level of mathematical skills displayed by many students, particular in the UK (Sutherland and Pozzi, 1995). In this paper, the term *support centre* should be interpreted to mean a facility, which offers one-to-one tutorials to students, in addition to their regular teaching programme (i.e. lectures, tutorials and practicals). A survey carried out by (Lawson et al, 2001) analysed data collected via a questionnaire from 41 UK universities with mathematical support centres. Within this questionnaire, each university was invited to submit three positive and three negative aspects of their centres. The most frequently identified positive characteristic was the *one-to-one* support. This is largely because it provides focused help with immediate response to student's mathematical queries. As a result of research on student support centres, which have shown excellent results on student learning, the UCD School of Mathematical Sciences established the Mathematics Support Centre (MSC) in January 2004. It was funded by a Higher Education Authority (HEA) grant. Since then, the MSC has grown into a centre of excellence, which offers support in mathematics to students from all programmes.

In addition to poor mathematical skills, computer programming, core of any Computer Science (CS) degree, is a major stumbling block for many students. In particular, first year students find computer programming difficult to learn. There are several reasons for this. First, students enrolling in CS have no prior programming experience or knowledge in CS subjects in general. The lack of prior computing experience alone does not seem to be a problem. The more central issue is the lack of problem-solving skills. Dunican (2002) indicates that subjects offered in secondary schools in Ireland fail to cover logic/problem-solving topics, and this creates difficulties for students at third level. In relation to the CS students a further difficulty is the programming syntax. Even students with adequate problem-solving skills can find it difficult to convert *pseudo code* into a syntactically correct *computer program* (Dunican, 2002; Kölling et al., 2001; Sheard et al., 1998).

As a result of these difficulties, many first year students struggle with CS and

mathematics subjects. Consequently, their initial enthusiasm for mathematics and computer programming fades rapidly as the difficulties emerge. Furthermore, Jenkins (2001) pointed out that such challenging aspects might demotivate students, and conclude that if students are not motivated, they will not learn. Some of the students who struggle with programming or mathematics may drop out of these courses. Moreover, some CS students may try to avoid programming projects and ultimately choose a career path that does not involve programming (Stamouli et al., 2004). To improve student retention and reduce the effects of the aforementioned difficulties, two forms of support have been tested within the CS domain to date. The first is the introduction of *mentoring classes* (Miliszewska et al., 2007), and the second is the establishment of a *support centre* (for example, see Stamouli et al., 2004). Within the School of Computer Science at UCD, we chose the latter option, and established the UCD Computer Programming Support Centre (CPSC). This decision was motivated jointly by the success of the MSC and the desire to increase CS retention rates of undergraduate students.

In this study, we focus on the impact that the MSC and the CPSC have on student learning in providing support in mathematics and CS subjects. For each centre, we provide basic information such as the number of students seeking help, their most common difficulties, and also give some insight into the manner in which the centres' resources are used. For instance, we examine statistics such as the frequency and length of their visits. We also analyse their effectiveness in relation to student learning. This is measured in terms of student satisfaction and pass rates. Both centres have achieved very high pass rates (> 95%) in assisted modules. This evidence is gained from the evaluation forms filled annually by students who visited both centres. This suggests that they are both highly effective at aiding students to pass exams in those modules.

This paper is organised as follows: Sections 2 and 3 describe the MSC and the CPSC. In Section 4, we present an evaluation of both centres and evaluate their ability to support students. We conclude in Section 5 with summary of our findings.

2. The UCD Mathematics Support Centre (MSC)

The MSC aims to provide mathematics support for students of all mathematical abilities on a one-on-one basis, in a friendly, relaxed and informal atmosphere. A further aim is to enable students who are experiencing particular difficulties in mathematics to overcome their fear of the subject, take control of their own learning and build confidence in their own mathematical ability.

The MSC currently opens from 10:00 am to 5:00pm on Mondays, Tuesdays, and Thursday, then 10:00 am to 7:00pm on Wednesdays and Friday mornings 11:00 am to 1:00pm. It operates as a dedicated drop-in centre and is staffed by friendly and experienced mathematical tutors. In addition to one-to-one tutoring, the MSC also provides services such as supervised study, provision of relevant textbooks and handouts, access to web-based learning materials including self-diagnostic tests and the provision of *hot-topic* tutorials throughout the semester. *Hot-topic* tutorials are group sessions that cover specific topics, as identified by the centre as those that many students have difficulties with.

When the MSC was first established, it was expected that the majority of its visitors would be students enrolled for mathematics programmes such as *Statistics*, *Actuarial Science*, or *Mathematics*. While a significant number of MSC visitors to date still fit this profile, we have recently observed a *new* type of visitor. This includes students from non-mathematical related programmes, where mathematics modules are not core. In fact, it currently offers support to students from 57 out of 81 UCD programmes. This represents over 70% of all UCD undergraduate programmes. For example, students studying *Agriculture*, *Architecture*, *Chemistry*, *Commerce*, *Computer Science*, *Economics*, *Geography*, *Medicine* and *Nursing* were some of those tutored by the MSC during the 2009/2010 academic year. This high percentage illustrates the key role that the MSC plays in supporting a wide range of third level students in UCD.

3. The UCD Computer Programming Support Centre (CPSC)

In September 2008, the School of Computer Science and Informatics established the UCD Computer Programming Support Centre (CPSC). Since then it has become a fully operational centre of excellence which aims to provide a positive, supportive

atmosphere where students with programming and other computer science related difficulties can seek one-to-one assistance throughout the year. The CPSC also aims to support students who are in transition from second level education. However, unlike mathematics, students who enter into Computer Science have little or no prior exposure to CS-related topics.

The CPSC also operates primarily as a drop-in service where students are encouraged to seek help when required. This is provided either on a one-to-one basis or in a group teaching session. Additional services such as programming advice and the provision of student self-diagnostic tests are also provided. Similar to the MSC, the CPSC employs a team of skilful tutors in the key modules of computer science. It opens between 10:00 am and 4:00 pm from Monday to Friday. The opening times of both centres were extended this year due to the increased number of students attending and student feedback. Unlike the MSC, students who visited the CPSC are primarily Computer Science students. However, about 5% of our present attendees are studying alternative degrees such as *Engineering*, *Mathematics* and *Economics*.

One of the major benefits of any support centre is that the information, detailing why students attend, provides us with valuable insight to help identify the common difficulties experienced. All the data collected by the CPSC and the MSC is recorded and stored for analysis purposes. More specifically, we record the year of the student, their programme, the module with which they are having difficulties, the length of the visit, and the topics covered by the tutor during the session. The MSC additionally records basic second level mathematical difficulties experienced by the students. Finally, to facilitate an analysis of the issues encountered in the CPSC, each problem is classified into one of six major categories as follows:

1. **Concept Understanding:** This category relates to cases where the students require help understanding a particular concept.
2. **Implementation/Syntactic:** This category relates to cases where the students need help for creating syntactically correct program codes or for debugging incorrect programs.
3. **Algorithmic Problem Solving:** This category relates to cases where the students need help for solving algorithmic related problems.

4. **Proof Techniques, Maths and Logic Issues:** this includes students who have mathematics, logic, and general proof technique related issues.
5. **Assignment Understanding:** This category includes students who have trouble understanding a particular assignment.
6. **Technical Support:** This consists of cases where the students require technical support such as installing java.

It is important to note that the above classification scheme was only used to categorise CPSC tutorials. This scheme is used in Section 4 to determine the most common issues held by CPSC visitors.

4. Evaluation

In this section, we examine the role played by both centres in assisting and supporting students to overcome mathematics and computer science related obstacles. More specifically, we wish to answer the following questions:

- How has the overall usage of both centres changed since they first opened?
- Which student stages are more prevalent visitors to both centres?
- How often does a typical student visit the centres? How long does the average tutorial last?
- What are the most common types of problems identified by both centres?
- To what extent do the centres aid students to pass the exams of modules for which they seek help?

The number of students that visit such centres can be viewed as a measure of how the students value the centres. Therefore, we begin by analysing the level of usage of each centre since they both opened in 2004 (MSC) and 2008 (CPSC), respectively, in Figure 5.1. The number of visits to the MSC has grown steadily since 2006. In 2009/2010, there were 3,508 visits to the MSC, which reflects an increase of 46.1%, compared with the previous year's figures. Since the CPSC only opened in 2008, less data is available to judge its overall usage. However, in the 2009/2010 academic year, there were 634 tutorials held in the CPSC. This reflects a 61.3% increase compared to 2008/2009. However, these figures are significantly lower than those of MSC. There are two possible reasons for this Firstly, it is important to remember that mathematics is covered in a much larger number of UCD programmes than computer science. This

is reflected by the fact that the MSC currently tutors students from over 70% of the programmes offered by UCD. Secondly, this increase may also be affected by the fact that the MSC is longer in existence, and as a result has a more established reputation throughout the campus.

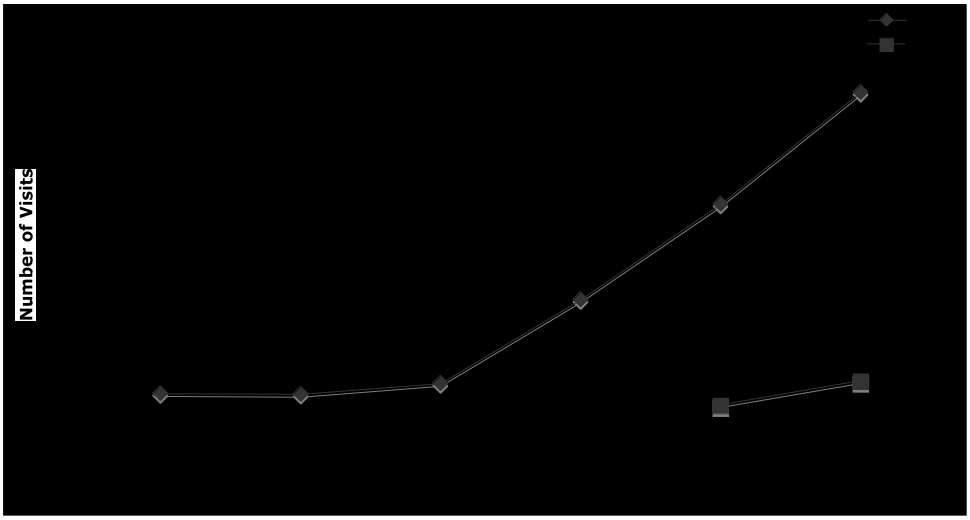

Figure 5.1 – Annual number of visits to the MSC and the CPSC during 2009/2010.

Figure 5.2 shows the percentage breakdown of the different levels of students that received assistance from the MSC and the CPSC during 2009/2010 academic year. In this graph, *Other* represents postgraduates (Higher Diploma, MSc, etc.) students. As depicted, stage 1 students formed the majority of the MSC attendees (73% of the total number). The percentage of stage 2 students visiting MSC increased from 17% in 2008/2009 to 20% in 2009/2010, and there was an equivalent decrease in stage 3 students. A slightly different set of trends is observed when we analyse the CPSC figures. We expected stage 1 students to form the majority of our attendees. However, to our surprise this is not the case. The majority of visitors to the centre were stage 2 students, which represent 41% of the CPSC visitors.

Interestingly, a similar trend was exhibited in 2008/2009. Originally we had thought that this was caused by the fact that stage 2 students did not have the support of the centre in stage 1. However, the fact that the trend has repeated itself might suggest that the material in second year may be causing more difficulty amongst the students. This may indicate that the move, which students are expected to take in progressing from stage 1 to stage 2 in the Computer Science degree programme may be too high. This trend will be monitored such that necessary curriculum changes can be made in subsequent years.

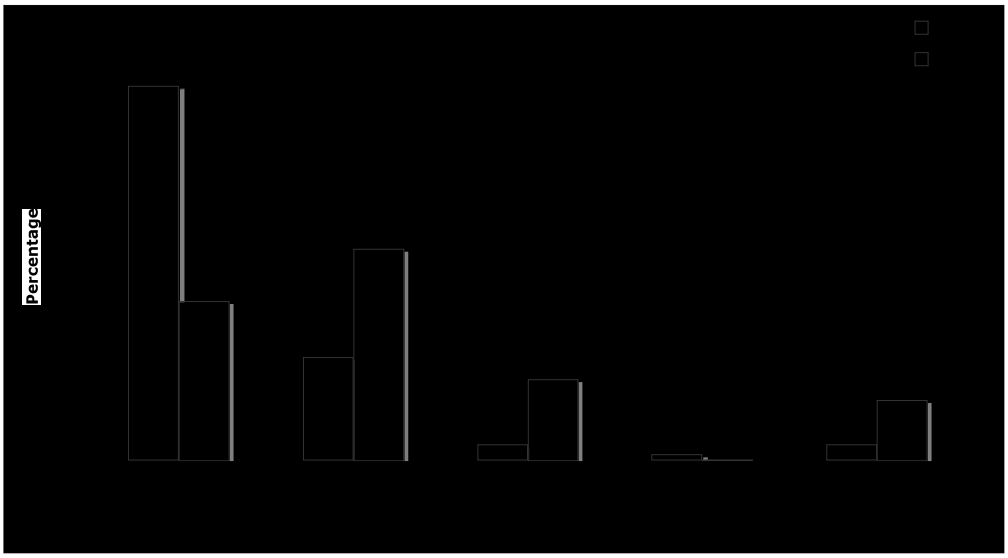

Figure 5.2 – Percentage of visits to the MSC and CPSC by student Stage/Year in 2009/2010.

We now wish to analyse how a student utilise the centres. In particular, we examine how often a given student visits, and analyse the length of each visit. In 2009/2010, the average time spent by a student in the MSC was just over 71 minutes. The CPSC average tutorial length was a little lower at 53 minutes. Similar averages were experienced in both centres in previous years. Figure 5.3 shows the frequency of student visits to both centres. Across both centres, approximately 40% of the students made only one visit, 20% visited twice and the remaining 40% required three or more visits to resolve their difficulties. In fact the number of MSC visits by any one student ranged from 1 to 44, with median value of 2 visits. In the CPSC, this number ranged from 1 to 23. This data suggests that students who visit specialised support centres such as the two discussed in this paper can be categorised into two distinct classes. The students, who attend only once, are typically those who have a minor problem/misunderstanding regarding some concept or gain sufficient knowledge in

attending a hot topic session. The second type consists of students who make multiple visits. Some of these students may have major problems in basic mathematics (e.g., mature and international students, etc.) or possibly have extenuating circumstances (e.g. illness, bereavement).

All CPSC queries were categorised into one of six categories (as described earlier in

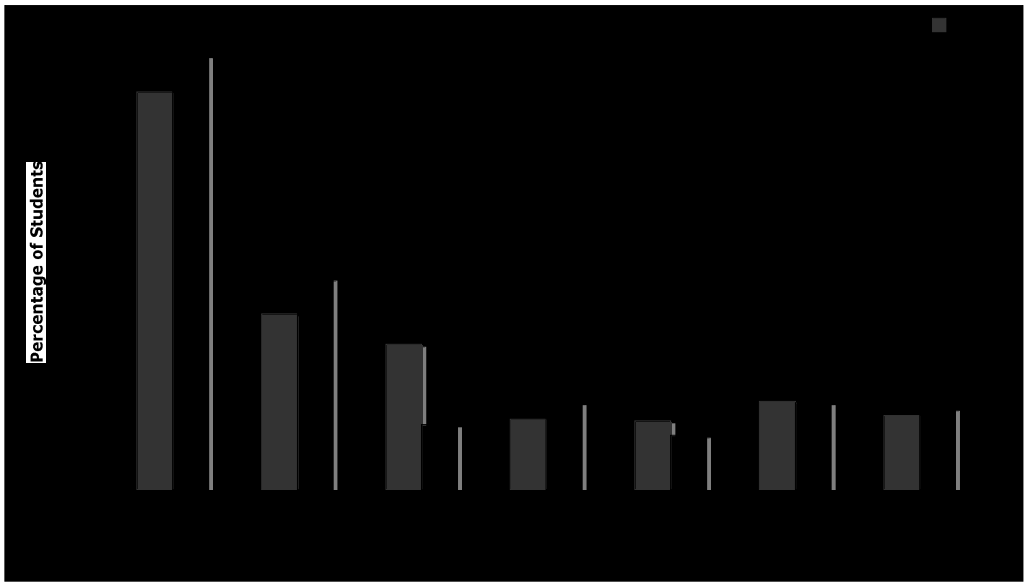

Figure 5.3 – Percentage breakdown of the frequency of student visits to the MSC and CPSC.

Section 3). This analysis revealed that 52% of their queries were related to program syntax and implementation issues, and almost 30% of the cases were issues relating to the understanding of a particular concept. These trends are in line with trends shown in related studies (such as (Dunican, 2002)), which suggest that programming concepts tend to be difficult to grasp, and that students have much difficulty generating syntactically correct program codes.

In order to fully assess the impact of both centres, it is vital to determine the extent to which the centres help students. To examine this we collected feedback from students who attended both centres using annual evaluation forms. An analysis of this data revealed that students who visited the MSC during 2009/2010 passed 97% of the modules for which they sought help. This yields an increase of 3% when you compare it to the last year's rate (94%). Similarly, those who visited the CPSC during this period passed 96% of their modules.

In addition to assisting students learning, another common objective of both centres is to increase student retention rates. However, our ability to effect retention figures is extremely difficult to quantify. For instance, often students drop out because they lack confidence in their programming/mathematical ability. Yet with the appropriate assistance it is possible for them to overcome their difficulties. This is evidenced from the evaluation forms, which asked the students to describe their experiences with the CPSC/MSC. The following are some quotes from these:

- *"I found the centre very helpful and I definitely wouldn't have got through my maths modules without it. I am very thankful to all the MSC tutors for helping me pass my modules."*
- *"The CPSC is a great resource particularly when you feel like I did many times: under pressure, stuck or completely lost. It is impossible to walk out of there with any worries or questions left."*
- *"I found the MSC very helpful. It increased by confidence with Mathematics."*

It is also well known that throughout all disciplines stage 1 students have one of the highest drop-out rates. These students often require a little extra support to adjust to third-level programmes, and are often reticent to seek help. One-to-one support is particularly important for these students.

4. Conclusions

For the majority of Computer Science (CS) subjects, hands-on learning is becoming the only effective way to get the students to fully understand concepts such as *programming*. CS is not just about manipulating some program codes. It requires constant engagement with new materials and ideas. Programming and problem solving must be *practical* to be understood. Currently, the manner in which the majority of CS courses are designed does not favour hands-on learning. One of the questions we would like to answer; *Do students learn and retain more knowledge through one-to-one interactive tutorial sessions?* Our data shows that students who have difficulties and get assistance from the CPSC/MSC tend to learn more and are more likely to pass those difficult modules. The number of students attending the MSC has increased substantially year by year. In addition, the MSC covers an increasing number of programmes throughout UCD. Both of these are measures of demand. However, evaluation forms are in some way biased. In future work, we hope

to compare the pass rates of students who attended the centres to the pass rates of those who did not. This analysis will help to provide more accurate evidence on the effectiveness of the centres. We will continue to evaluate both centres' practices and accommodate student needs. We will also continue to refine our current support methodology and look for more effective ways to enhance student learning.

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