Addressing mathematical deficits – the role of mathematics learning centres

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There is a prevalence of mathematical deficits in higher education. This is exacerbated by the increasing number of students entering through non-traditional means. The ability to address these deficits, either prior to the commencement of an undergraduate degree or through the provision of additional mathematics assistance, is therefore vital for student success. This paper examines strategies implemented by a mathematics learning support unit in addressing mathematical deficits. As confidence is an essential component of learning, it is crucial that any course or assistance increases both confidence and mathematical knowledge. The two studies reported in this paper investigated student confidence levels upon commencement and completion of preparatory courses. The benefits of dedicated study spaces with tutor assistance, to encourage independent learning as effective and efficient methods of decreasing mathematical deficits was also investigated. The results of these studies highlight the importance of mathematics learning support units in universities. These units and their integrity should be preserved both nationally and internationally.
Key words: Mathematical deficit, knowledge gaps, self-assessment, mathematical confidence, independent learning

Introduction

Mathematics is in a crisis globally. Students are entering higher education with either inadequate skills in mathematics or graduating with poor mathematics skills (Golden & Lee, 2007; Hoyles, Newman & Noss, 2001; Varsavsky, 2010; Wood, 2010). The increasingly weaker mathematics background of university entrants and the resulting consequences have been reported around the world (Varsavsky, 2010). Ball, Lubienski and Mewborn (2001) ask the question “Why does formal schooling in the United States manage to help so many people learn to read and to write successfully and yet fail with so many others in developing a similar level of mathematical proficiency?” (p. 433). This is a worldwide question.

Numerous efforts are being made internationally by universities in an attempt to reduce the mathematical knowledge deficit in students, including implementing bridging programmes and assistance through learning centres (Varsavsky, 2010). As the mathematical knowledge gap between secondary school and university broadens (Hoyles et al., 2001), mathematics learning centres are becoming increasingly important. These independent units, which are typically separate from the faculties, are in an ideal position to foster independent learning practices which are vital for academic achievement. The facilities offered by these centres are providing “lifelines for students in areas with the greatest problems and inner conflicts in perceptions of the roles of mathematics both directly and indirectly in their disciplines” (MacGillivray, 2008, p. 24).

Varsavsky (2010) noted that confidence levels and self-motivation are recognised as important factors in student success in the study of mathematics. The studies conducted by CQUniversity (CQU) Australia’s Mathematics Learning Centre (MLC) and reported in the paper investigated student confidence levels upon commencement and completion of preparatory courses as well as the benefits of dedicated study spaces, with timely intervention from a tutor, as required, to encourage independent learning as effective and efficient methods of decreasing mathematical deficits.

Study overview

This paper reports on two studies conducted by the MLC. The first, conducted in 2010, surveyed students who are accessing the MLC student support service. The second, conducted in 2011, surveyed students enrolled or who have completed one of our preparatory mathematics courses (Transition Mathematics).

The 2010 study invited undergraduate students accessing the MLC services to complete an MLC survey containing a selection of multiple choice, scaled and open ended questions. Surveys were available within each of the MLCs with dedicated rooms or available from staff members on campuses without dedicated study rooms. Completion of the surveys by on-campus students was optional because anonymity was not guaranteed. Distance students who had contacted the MLC via email were posted a paper based survey. No follow up was conducted to verify students’ participation. This study investigated the ability of dedicated MLC study spaces to enhance independent learning practices, the value of resources supplied to students and the value of the support provided. Anecdotal evidence from student comments had supported both the belief that dedicated spaces were more conducive to independent learning (over appointment based tutorials in staff members’ offices) and that distance students appreciate the type of support afforded to them through the use of the Tablet PC.

Forty-four students participated in the 2010 study, comprising 14 males and 30 females ranging in age from 19 to 62. The study was conducted across four of the CQU domestic campuses and included students studying internally or by distance as well as those studying part-time or full time. Of the students surveyed 75% attended the MLC on a campus. Those students attending the MLC on a campus included students studying in all modes.

The 2011 study invited students who had been enrolled in any of the Transition Mathematics courses as an external student during 2010 or 2011 to complete a 5-10 minute online survey.

The aim of this study was to determine if Transition Mathematics courses with supportive frameworks increase mathematical knowledge and confidence in students studying externally. Anecdotal evidence suggested that many students entered the courses with a fear of mathematics that was often reduced or relieved as a result of the course. There was also the belief that the resources supplied with the course and the formative assessment and feedback were a vital part of increasing confidence and success.

This study surveyed students regarding their mathematical confidence prior to and after completing one or several of the Transition Mathematics courses. Students were also questioned on the usefulness of extra study resources and support supplied with the course. As all students were studying in distance mode it was vitally important that they engaged with the material and did not feel isolated.

1. Mathematics deficiency as a global phenomenon

Studies conducted in various countries throughout the world reveal an increasing number of students entering university with diminished mathematics backgrounds or abilities and the resulting consequences (Varsavsky, 2010). The global trend to increase enrolments and accept a broader range of students is resulting in a "much greater diversity of numeracy, mathematical skills and knowledge backgrounds across tertiary cohorts" (MacGillivray, 2008, p. 15). The mathematics deficit exhibited by students entering university is "symptomatic of a general denial of mathematics for more than a decade, the consequences of which must now be acknowledged and faced by all types of universities" (MacGillivray, 2008, p. 27).

Within Australian universities there is an escalating trend to remove or reduce the number of prerequisite subjects in order to maximise potential student enrolments (Wilson & MacGillivray, 2007). Combined with the removal of mathematics as a compulsory subject in years eleven and twelve an increasing number of Australian students are choosing not to study mathematics beyond year 10. This trend has resulted in student under preparedness when entering higher education (Varsavsky, 2010). Wilson and MacGillivray (2007) found that even when students complet senior high school algebra and calculus they still require assistance with basic mathematics at a tertiary level.

In the UK, Golden and Lee (2007, p. 1) cite "changes in post-16 school curriculum in mathematics and the impact of widening participation strategies for promoting access to higher education" as reasons for the decline in mathematics preparedness. Further, students returning to study after a substantial break and those from non-traditional backgrounds tend to have reduced confidence in their ability to master mathematics at university.

Ingersoll and Perda (2010, p. 563) note that several U.S. governmental reports "have directly tied mathematics and science teacher staffing problems to a host of educational and societal problems". These problems include "the inability to meet student achievement goals", "low U.S. educational performance compared to other nations", "the minority achievement gap", "national economic competitiveness", and "the security of the nation". The problem created by the shortage of qualified mathematics and science teachers is cyclic. Shortages force many schools to lower standards in order to gain teachers which in turn lead to high levels of underqualified mathematics and science teachers and lower student performance (Ingersoll & Perda, 2010).

Internationally higher education institutions are changing their educational focus and accepting students from a much wider range of academic backgrounds resulting in mathematical deficiencies. Hoyles et al. (2001) conclude the demand for employable skills has reduced mathematics to a series of topics, thus removing the higher-order attributes that provide conceptual glue enabling the interlinking of topics and deductive logic.

2. CQUniversity Australia (CQU)

CQU is a regional university primarily located in Queensland Australia. It has five domestic campuses located along the coast of Queensland and international campuses located in four Australian major cities. In 2010 65% of the 11626 domestic students were studying by distance. Rather than simply providing programmes of study, CQUniversity's goal is to provide student learning through flexible learning environments and personalised support. As noted by Barr and Tagg (1995, p. 13), a university's "purpose is not to transfer knowledge but to create environments and experiences that bring students to discover and construct knowledge for themselves, to make students members of communities of learners that make discoveries and solve problems". CQU has a history of accepting students from non-traditional educational backgrounds; Vice Chancellor, Scott Bowman (n.d.), observes "CQUniversity has supported mature learners for decades and recognises a range of qualifications and life experience".

3. The Mathematics Learning Centre (MLC)

The Mathematics Learning Centre at CQUniversity commenced with its operation in 1984. The MLC's two main responsibilities are to:

1. Deliver Transition Mathematics courses into the Skills for Tertiary Education Preparatory Studies (STEPS) programme; and
2. Provide academic assistance to undergraduate students experiencing difficulty with a mathematical component of their programme.

3.1. Transition Mathematics Courses

The MLC delivers three levels of Transition Mathematics courses into the STEPS programme. The level of Transition Mathematics required is dependent on the student's mathematics knowledge and chosen undergraduate degree. Each of these courses can be studied in internal or distance mode depending on the availability in the term of study.

- Fundamental Mathematics for University (FMU) – a course in elementary mathematics designed to have the student commence work on the foundation concepts, rules and methods of basic mathematics. The main aim of this course is to provide a refresher course in those fundamentals of basic mathematics which are necessary to develop mathematics as a unified body of knowledge. In 2011 there were approximately 670 external students enrolled in FMU.
- Intermediate Mathematics for University (IMU) – an intermediate preparatory course designed to follow on from FMU and a pre-requisite for TMU. IMU contains five core

and four elective modules with the choice of electives governed by students' future study plans. In 2011 there were approximately 120 external students enrolled in IMU.

- Technical Mathematics for University (TMU) – a technical preparatory course designed to follow on from IMU. The combination of IMU and TMU meet the prerequisite requirements for engineering and applied science and provide a mathematical foundation similar to Queensland Mathematics B. In 2011 there were approximately 60 external students enrolled in TMU.

Accommodating the diverse mathematical backgrounds of students is a major issue faced by the MLC staff, particularly when courses are delivered externally (Adams, Elliott & Dekkers, 2010). Although students are provided with comprehensive resources (including Study Guides and detailed textbooks), it is extremely difficult for some students to learn from text-based materials, especially as "the nature of mathematical sciences dictates that students need to hear the instructor explain the concepts and ideas" (Amin & Li, 2010, p. 47). MLC staff have carefully considered ways to engage students while still conveying important mathematical concepts. These include: instructional videos; electronic study guides that provide direction; formative assessment with handwritten electronic feedback; exercises and tests to encourage self-assessment; and support.

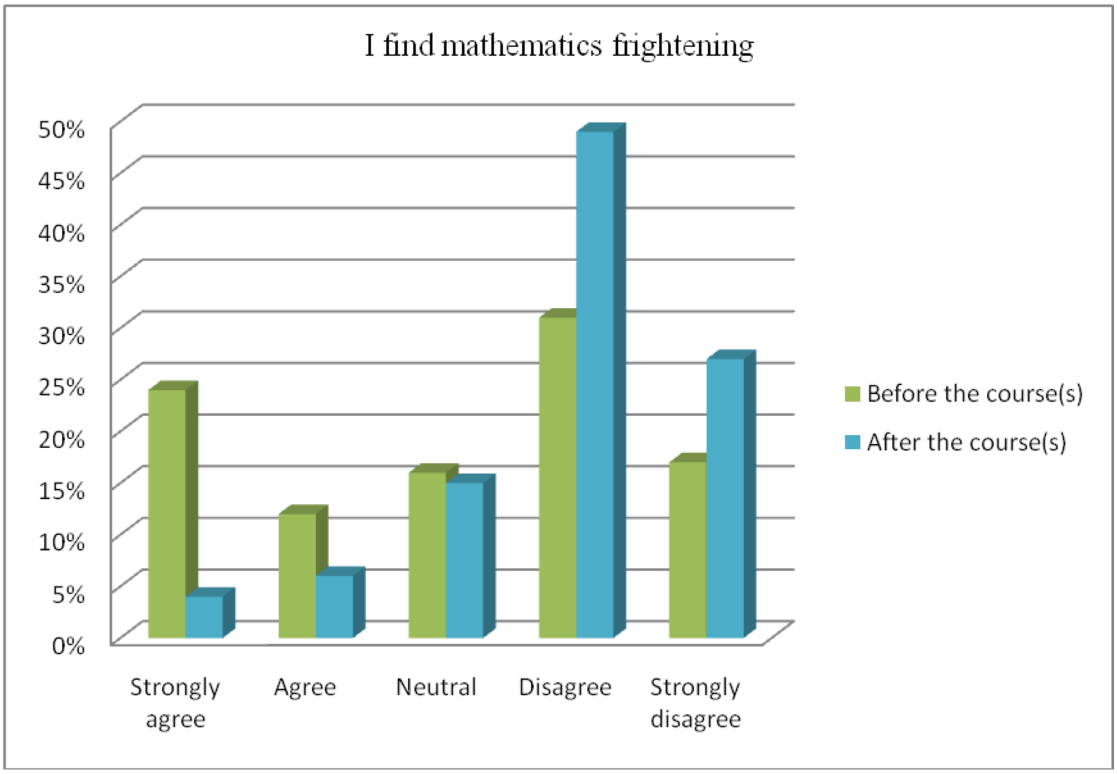
To determine if Transition Mathematics courses improve student confidence students enrolled in any of these courses during 2010 and 2011 were requested to complete a mathematics confidence survey. Prior to the commencement of any Transition Mathematics courses 36% of participants admitted to having a fear of mathematics this had reduced to 10% upon completion of at least one Transition Mathematics course (see figure 1). 44% of the students initially found mathematics confusing this number had reduced to 12% post Transition Mathematics course(s). It would appear that Transition Mathematics courses improve student confidence as well as improving mathematical knowledge. Student comments relating to mathematical confidence include:

Before starting this course, I was terrified of maths, but I now feel more confident and am actually enjoying the challenge.

I remember at school being taught maths; the teacher didn't take the time necessary to explain everything properly. Now, with FMU the explanations are much easier to understand. And I know it's only a phone call/an email away to get help

I was hopeless at maths at school due to the way it was presented. Since doing the Trans Maths course I feel somewhat confident due to the way in which it was presented.

Figure 1: Mathematics fear



3.1.1. Instructional Videos

In 2006 the first FMU distance offering within the STEPS programme was delivered. In an attempt to overcome the isolation associated with distance study and to provide students with step-by-step instructions, videos were created using the Tablet PC in conjunction with Camtasia® to complement the textbook. The videos enable students to see and hear the solutions unfold as if they had the lecturer with them. Within the videos the lecturer not only explains the concepts and ideas but also the mental processes involved in problem solving. Individuals whose motivation and application are frustrated by the tediousness and repetitiveness of attempting to learn by paper-based instruction are actively engaged via the instructional videos developed by the MLC (Dekkers, Adams & Elliott, 2011). It is important for students to be able to mentally plan a sequence of strategic decisions when forming a strategy for solving equations (Robson, Abell & Boustead, 2009).

In order to create the videos, the course developer begins by developing background slides. Although some believe that it is more authentic to have handwritten slides (Harrison, Pidcock & Ward, 2009), textbook files are used to create the outline of the slides. This not only saves time but also gives the videos a professional look and better aligns them with the textbook to aid continuity. Whereas the majority of slide templates for the FMU videos were created using Microsoft PowerPoint®, the IMU slides were created using Word®. The reason for the change was the flexibility afforded through the use of Word® (in regard to layout and the ease of inserting equations) and also the ability to use headers and footers to create unique and creative templates. Once the slides are created, they are converted to an

Adobe® PDF document. The creator then annotates directly onto the slides (using PDF Annotator® or Adobe Acrobat Pro®) whilst recording the screen using Camtasia®. Although it is possible to ink directly onto a Word® document or PowerPoint® presentation, these are not our preferred methods. Some staff choose to record the sound and video simultaneously while others add the sound as a narration after. Once the video has been created, any necessary editing is conducted and the video is rendered as a Flash® or Windows Media Player® file. An example of a slide template with annotations is provided in figure 2. As can be observed, these slides can also be used to deliver material internally.

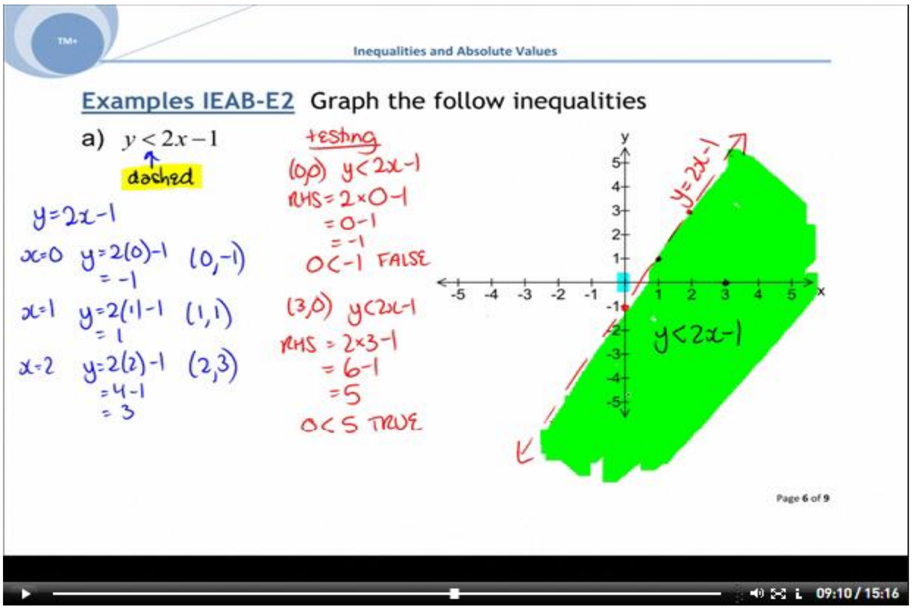
At the time of the study FMU had a complete compliment of instructional videos, IMU provided video support for core units of the course and TMU only provided videos for selected topics. From the survey, 96 FMU students watched the available videos, 17 IMU students watched the available videos and 5 TMU students watched the available videos. Across all three courses only one student found that the videos did not benefit their understanding of the concepts covered in the course. 87% of the students felt the videos enhanced the text book while 13% remained neutral. Only one student from the three courses did not find that the concepts were explained clearly. While the students found that the videos helped to improve their understanding of the mathematical concepts many of them felt that there was no substitute for face-to-face interaction with a tutor. Some of the student comments include:

While the instructional videos I watched were helpful nothing can equal face-to-face teaching. However I am unable to attend that mode of study for now.

I found the videos made everything very clear, while just trying to read the Study guide to understand the concepts was much more difficult

The videos were the reason I was able to understand the concepts more easily. Being able to see the problem written on the board and the ability to rewind it if necessary enabled me to achieve the results I did. This method of study would be wonderful to access in all courses.

Figure 2: An example of an IMU annotated video slide



3.1.2. Electronic Study Guide (ESG)

The ESG contains the entire set of course resources and can be accessed by the learning management system (Moodle) and/or a CD/DVD. The ESG enables students to easily navigate their way through the course, all with the click of a mouse. It is designed to provide students with weekly directions to keep them on track with their studies. As the student works through the week's instructions they are able to read the relevant sections of the textbook; watch instructional videos; complete and check textbook examples; and when they finish a module they can easily access the corresponding sample test (with worked solutions) before accessing and completing the end of module test for submission. The ESG also steps the students through the weekly requirements of the course as if they were attending lectures. This is facilitated by hyperlinks within the week's instructions.

The advantage of locating the ESG within the LMS is its dynamic nature. Additions and corrections can be ongoing, new videos can be made available as soon as they are created rather than waiting until the next DVD is due to be released. The advantage of an ESG on DVD is that it eliminates the necessity for students to download the videos from the LMS thus minimising cost, time and other complications associated with online learning.

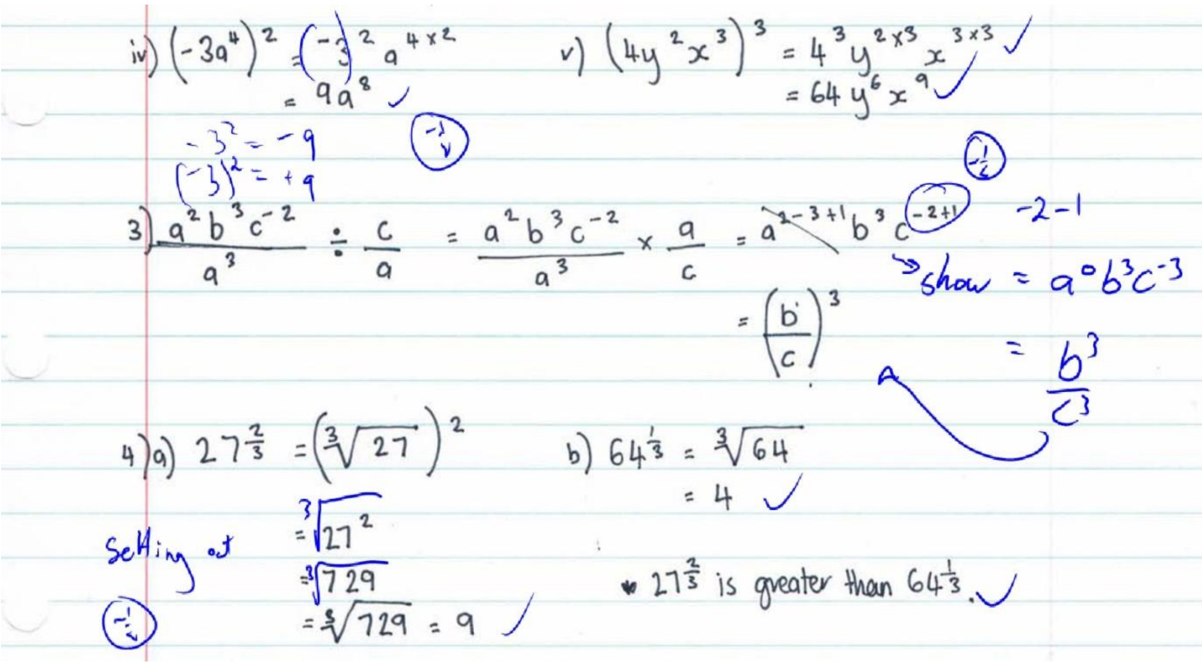
3.1.3. Formative Assessment

Killen (2005) defines any assessment that is used to acquire information for the purpose of adjusting teaching and learning as formative. Formative assessment provides students with a chance to reflect on given feedback with the knowledge that it will improve their chance of achieving a better grade (Tait, 2005).

Boud (2000) indicates the importance of student confidence and providing assessment that contributes to increased student confidence and their ability to learn. Formative assessment has the ability to do this by giving students feedback and the opportunity to improve on previous attempts.

Each Transition Mathematics course is composed of modules. Upon completion of each module students are requested to complete an End of Module Test. This formative assessment reviews the concepts covered in the module. Students can submit the test either electronically or in hardcopy format. All tests are marked electronically and students are provided with substantial feedback indicating where they made mistakes and how to correct them (see figure 3). On average 93% of the study participants were happy with the return time of formative assessments. The same number of students also believed that the feedback provided with the formative assessment was beneficial to their learning. Formative assessment is a key component of the courses. Dekkers, Adams and Elliott (2011) note that “the importance of feedback provided through formative assessment is not only an important part of the learning process but is also reciprocal” and “through the submission of the assessment, the student provides feedback to the lecturer, who in turn provides feedback to the student through marking and annotation”.

Figure 3: Corrected formative assessment



3.1.4. Support

Support for each course is offered by the course co-ordinators, the lecturers and the MLC. Students may contact staff for support via email, phone or in-person if they are located in the same city. If a student is experiencing difficulty with a problem or mathematical concept staff will attempt to provide the student with hand written solutions and explanations. For students unable to obtain in-person assistance, the tablet PC is used to provide the hand written solutions. Once prepared solutions are converted to PDF and sent to the student’s email account.

The study indicated that the more difficult the mathematics, the more support students require. While email support was sort by the majority of FMU and IMU students, TMU students preferred face-to-face support. It cannot be ascertained if this is a result of TMU not offering the same level of video support or if students experiencing difficulties in higher level mathematics courses require more personalised assistance. Extra support was sort by 39% of FMU students, 47% of IMU students and 69% of TMU students. Of the students seeking extra support the MLC provided on campus assistance to 21% of FMU, 23% of IMU and 45% of TMU students. It can be concluded that as mathematics courses become increasingly more difficult a greater percentage of students require extra assistance and face-to-face assistance becomes preferred.

3.2. Mathematics Assistance

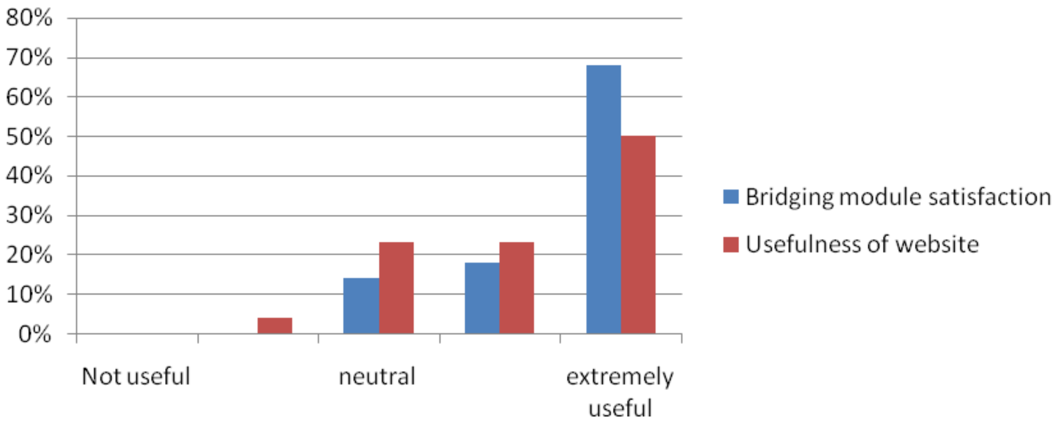
The MLC is a support unit which provides assistance to students who are experiencing difficulty with the mathematics or the quantitative component of their CQU course. Students requiring mathematical support are able to access the MLC for both individual and group tuition, according to their needs, regardless of faculty or school. Assistance can also be obtained through email, fax or telephone. Where students have omissions in the mathematical knowledge required to succeed in a course or fail to understand the mathematical concepts being taught, support is required to prevent attrition. All of the students surveyed found the MLC service useful and would recommend it to other students. When asked if they had discovered an improvement in their mathematics, 98% of the students found that there was at least some improvement with 68% of students attesting to a vast improvement in mathematical performance. Undergraduate students are also able to access bridging mathematics modules.

3.2.1. Bridging mathematics modules

The MLC offers a range of bridging mathematics modules for undergraduate students undertaking course work with a mathematical component. These modules are available as booklets that students can collect from any of the MLC centres or in PDF format available for download from the MLC website. Each module is topic specific. That is if a student recognises a shortfall in their knowledge of basic algebra, they can refresh that topic. For these modules to be beneficial, generally the students must have the ability to self-assess their own mathematical ability. Unlike the Transition Mathematics courses, in which students must enrol, these modules have no assessment and are reliant on the student's ability to be a self-directed learner.

Of the students that used the booklets 80% found them at least satisfactory with 68% of the students finding them to be an excellent resource (Figure 4). Having these resources available via the MLC website allows students to access the resources at their own convenience, thus, enhancing independent study habits. Providing materials via the Web reflects mathematics as a dynamic discipline with a range of intertwining concepts as opposed to the linear approach provided by text based materials. The Web affords opportunities to present the material in a more fluent manner, similar to the nature of mathematics itself. Through this structure "students can select and access material and content according to their needs" (Webster & Hackley, 1997, p. 1289). Only half of the students surveyed had used the MLC website. Of those students that did access the website more than half stated that they found the site to be very useful (figure 4).

Figure 4: Bridging module satisfaction and usefulness of website



3.2.2. Self-assessment and self-directed study

Self-assessment is the means by which the student or the learner determines through their own means whether or not they have grasped the concept or the task being learnt. "Self-assessment has long been known to have beneficial effects on learning and on the internal motivation of students" (Athanasou & Lamprianou, 2002). Boud (2000) also notes the positive effect of frequent self-evaluation on improving student accomplishments.

Students that are not effective self-assessors impede their ability to learn and perform well on assessment as well hinder their ability to cope with change (Boud, 2000, 2007). Often self-directed assessment is associated with self-directed learning.

The MLC encourages students to develop independent learning habits by providing assistance on an as needs basis. Small group tutorials are encouraged to entice students to interact and work together towards their own learning. The MLC does not provide an editorial service or check student assignments. On campuses with dedicated MLC spaces students can work independently and seek assistance from the duty tutor when required. Knowing that assistance is nearby increases the student's confidence to work independently. Of the students surveyed that attended MLCs with dedicated study spaces, 82% found the space to be conducive to independent learning and study, with the remaining 18% maintaining neutrality. Additionally, of the students who thought the space was beneficial, 66% rated it as excellent. 51% of participating students attended the MLC because they recognised their failure to comprehend a concept, topic or problem in a lecture, tutorial or in their textbook, indicating their ability to self-assess. Through the use of diagnostic testing and reciprocal relationships between the MLC and the faculties students are better able to self-assess. McDonald and Boud (2003) found that self-assessment training should be incorporated as part of the curriculum. This is facilitated through the embedding of skills audit tests and bridging mathematics within undergraduate courses.

3.2.3. Embedding in undergraduate courses

To address the growing mathematical knowledge deficit in students entering university, many universities are attempting to embed mathematics learning support within the content of their undergraduate courses. Within CQU an increasing number of mathematics and statistics courses are embedding learning support. Though the embedded material is not as extensive and sophisticated as other universities, especially some within the UK (Golden & Lee, 2007), it does assist students in self-assessment of their mathematical knowledge and encourage either self-directed study or self-referral for further assistance.

Within the UK, government funded projects and collaboration between universities has resulted in web and text based mathematics learning support resources being made available (Golden & Lee, 2007). These resources are then able to be embedded into individual university courses. Unfortunately within Australia the varying intellectual property policies across universities make the sharing of teaching materials difficult (Porter, 2011).

> Despite the turf wars, however, it remained the case that, addressing the need for learning support arising from students' poor mathematical skills required and still requires, collaborative effort and a coherent framework in which the provision of learning support can be aligned with the subjects/disciplines that are generating the need. While through this project a sustainable infrastructure has been created for hosting a resource collection, there remains a need for universities to encourage staff to fully populate the repository with good quality peer reviewed resources (Porter, 2011, p. 11).

3.2.3.1. CQU courses with embedded mathematics support

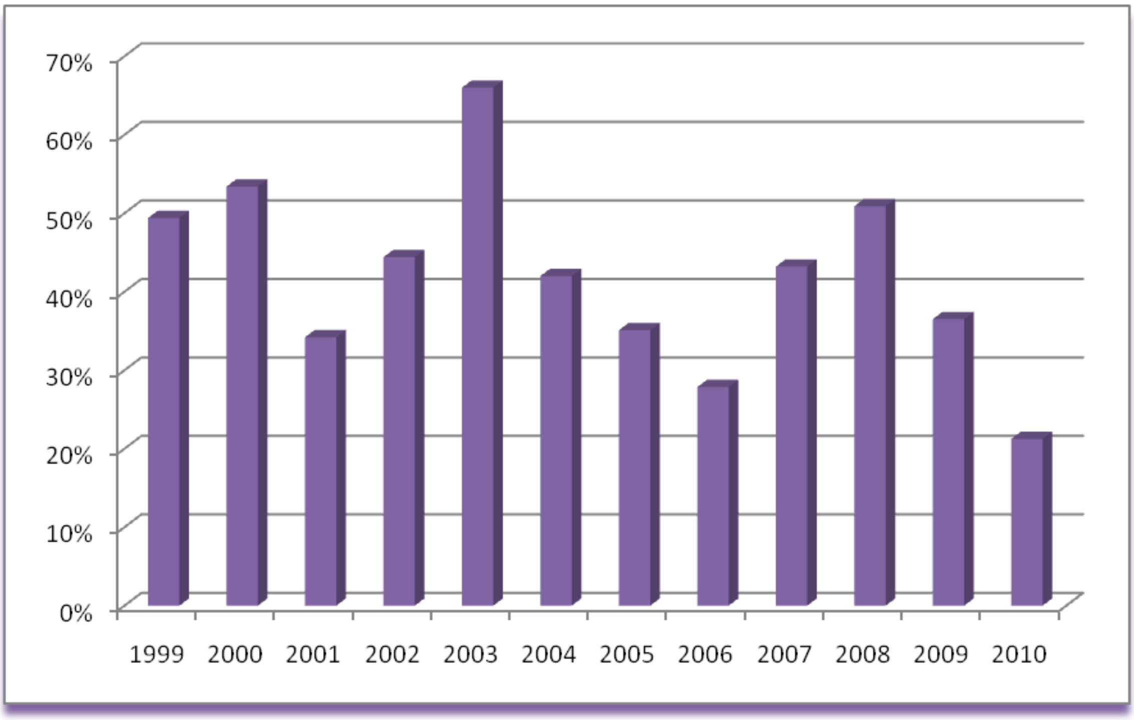
The number of courses at CQU with embedded mathematics support is increasing. Much of the embedded support has been developed by the MLC. This support includes skills audit testing for students, the provision of bridging mathematics modules and videos to cover basic mathematical concepts. One CQU course in particular has worked with MLC staff to embed bridging mathematics within the course and reaped the benefits.

3.2.3.1.1. Technology Mathematics

Technology Mathematics is a basic technical mathematics course which introduces students to calculus. The majority of the students studying this course are enrolled in the Advanced Diploma of Engineering. It is also the primary mathematics course offered as part of the Mining Engineering Cadetships available in conjunction with mining companies in the Bowen Basin, Queensland. Traditionally students entering this subject have had little previous mathematics education and/or had not studied for a substantial period. In 2010 there were 156 students, including 136 males and 20 females, studying Technology Mathematics with an average age of 27 years. The age range of student varied from 17 to 52.

In 2008, due to the previous relative high failure rate (figure 5), the Course Coordinator of Technology Mathematics and the MLC staff collaborated to embed skills audit testing and bridging mathematics into the course. The skills audit testing was available through the course web site. It consisted of multiple choice questions that enabled the student to test their basic knowledge of mathematics. The advice given as a result of the first attempt varied depending on the score obtained by the student. Students with an extremely low score were advised to withdraw from the course and enrol in the FMU preparatory course. Students whose score indicated sound mathematical understanding but the appearance of some gaps in content knowledge were advised to complete the relevant bridging mathematics module, available from the website. All modules were available to all of the students regardless of their skills audit test score. Students experiencing any difficulties throughout the course were able to contact the MLC for assistance. In 2010 approximately 21 of the 156 students contacted the MLC at least once for assistance. Some of the students contacting the MLC returned on a regular basis.

Figure 5: Technology Mathematics failure rates



Failure to avail mathematics support

Even though MLCs, especially those with dedicated study spaces, have been proven to improve student grades, mathematical confidence and independent study practices, these services remain underutilised. Grehan, Mac an Bhaird and O'shea (2010) found that "students 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" and "were also reluctant to ask for help and feared embarrassment". Of the 11626 domestic students enrolled at CQU in 2010 approximately 800 individual students contacted the MLC for assistance, many of these students used the service repeatedly. This represents approximately 7% of the domestic student cohort. Given that 51% of the surveyed students heard about the MLC from the course lecturer or tutor and 65% of the students study by distance, it could be assumed that many students are not even aware of the service. Knowing how important MLC support is, how then do we make students aware of these services and not be afraid to utilise them?

4. Conclusion

Throughout the world students are neither entering higher education with adequate skills in mathematics nor graduating with strong mathematics skills. Globally attempts are being made by mathematics departments and mathematics support units to implement strategies for rectifying the situation. The MLC at CQUniversity Australia conducted two studies, one on preparatory courses and the other on assistance, to ascertain if services provided by the MLC improved confidence, the ability to self-assess and increased independent learning practices. All known factors to improve learning.

Findings from the studies showed students reported an increase in both their confidence levels and their mathematical skills. Transition Mathematics courses which provide scaffolding and support provide students with the confidence and knowledge to undertake undergraduate studies. Dedicated study spaces with the availability of a tutor encourage independent learning practices. Embedding of mathematical support within courses has proven to reduce failure rates while providing students with the ability to self-assess.

In the present academic climate of widening participation and the growing prevalence of gaps in mathematical knowledge, mathematics support centres are becoming substantially more important. In Australian as universities continue the trend of scaling back services, there is increasing need to highlight the vital performance of these services in bridging the mathematics knowledge gap and reducing attrition. The integrity of mathematics support units in universities both nationally and internationally should be preserved.

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