

Undergraduate Mathematics and the Role of Mathematics Learning Support

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Mathematics learning support can take many forms both in the nature of its instruction and the nature of its operational structure. This paper reports on the nature and history of mathematics learning support in Australia as it relates to undergraduate mathematics, both overt and embedded. It describes the aims of many mathematics support practitioners and present a model for program development based on the work of Keimig [7] with some recommendations for future practice.

Introduction

The changing nature of Australian universities has resulted in a student intake with a broad range of abilities, attitudes and personal and educational experiences. In 1995 McInnes and James [1] in their study of the first year on campus revealed that uneven preparedness was a problem for many tertiary institutions, with mathematics in particular cited as a barrier for success of many students. The proliferation in Australian universities up to 1994 of 'learning centres' with numeracy/mathematics experts [2] confirms that the tertiary sector had identified a need in this area. Both the 1997 Symposium on Modern Undergraduate Mathematics and the 1999 Joint Australian American Mathematical Society Meeting were well attended by staff from the maths support areas. Further in separate surveys conducted along similar lines by the University of Adelaide [3] and The University of Southern Queensland (USQ) [4] in 1995 and 1998 respectively, academics were still concerned by the mathematical proficiencies of first year students. Yet, mathematical support programs in some universities continue to be under the threat of review, inadequate budgets and marginalisation. In a sample of university web sites in Australia 20% of universities had no readily identifiable mathematical support program(s). This paper will examine the nature and aims of mathematics learning support and propose a model for future development.

The nature of mathematics learning support

Provision of mathematics learning support has a multifaceted origin. Some impetus came from the concern about the ability of first year students to manage traditional undergraduate mathematics programs while other influences came from the difficulties students had with supposedly non-mathematical subjects such as, nursing, psychology or economics (termed embedded mathematics programs). The site of first concern appears to be related to the position of mathematics learning support programs within university structures. Figure 1 details this relationship. A survey of accessible web sites reveals that currently programs come from a range of locations within a university's structure (Table 1). Approximately 40% are located within mathematics departments. Here they are staffed entirely by academics with strong mathematical backgrounds who often also teach into undergraduate mathematical programs. In approximately 30% of institutions, programs are housed with the Student Services section of the university. These staff also have strong mathematical backgrounds but might also have counseling or teaching/learning skills and experiences. Some of these staff are employed under administrative awards rather than academic awards. Only about 12 % of programs are housed within special academic sections such as occurs at USQ within the Office of Preparatory and Academic Support at USQ. Overall, it is not uncommon for staff who work in

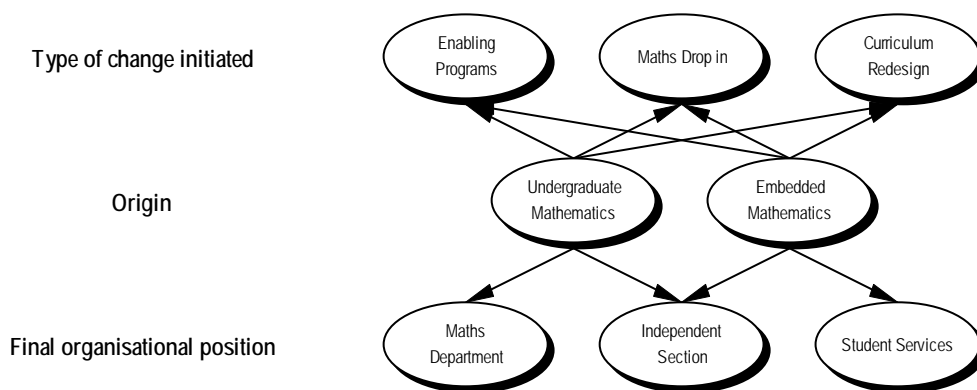
mathematics learning support areas to have experience teaching in either the primary, secondary or vocational sector, as well as in the tertiary sector.

Table 1: List of universities survey in this study (addresses are accessible from <http://www.avcc.edu.au/avcc/uniwebs.htm>)

[The University of Adelaide](#)
[The Australian National University](#)
[Bond University](#)
[Central Queensland University](#)
[Curtin University of Technology](#)
[Edith Cowan University](#)
[Griffith University](#)
[The University of Melbourne](#)
[Murdoch University](#)
[The University of Newcastle](#)
[The University of Queensland](#)
[University of South Australia](#)
[The University of Sydney](#)

[The Australian Catholic University](#)
[University of Ballarat](#)
[University of Canberra](#)
[Charles Sturt University](#)
[University of Technology, Sydney](#)
[The Flinders University of South Australia](#)
[Macquarie University](#)
[Monash University](#)
[The University of New England](#)
[Northern Territory University](#)
[Queensland University of Technology](#)
[University of Southern Queensland](#)
[University of Western Sydney](#)

Figure 1: Relationship between the origins of mathematics learning support, current programs and organizational position.



Once a reason for mathematics learning support is established, then a number of actions result. The actions could be categorized as Enabling programs, Drop-in, Curriculum redesign (Table 2).

Table 2: Summary of reactions to problems in undergraduate mathematics.

Enabling programs	Short bridging course before entry Semester or year long bridging courses before entry
Drop-in	Person-to-person support for short periods after entry
Curriculum redesign	Changes to curriculum structure of the mainstream unit independent of mathematics support initiatives Short workshops or tutorials after entry Integration of bridging and mainstream units Overlay of specialized programs (e.g. Supplemental Instruction)

Across Australia approximately 46% of universities offer drop-in support, 42% have curriculum redesign involving mathematics support initiatives and 35% offer pre-entry bridging courses in mathematics (taken from sample of 26 universities with web sites indicating mathematics support of some form). At USQ 65% of the 5000 commencing students participate in mathematics support of

one form or another once they enroll and approximately 1000 students participate in pre-entry programs (Tertiary Preparation Program).

Aims of Mathematics Learning Support

The specific aims of mathematics learning support differ between universities but the essence is the same.

To contribute to learning in mathematics by the provision of support, the creation of opportunities and the undertaking of research to increase positive outcomes in student learning

Central Queensland University (<http://www.cqu.edu.au/mlc/mammic.html>)

To develop and provide academic programs and resources to enhance learner independence.

The University of Southern Queensland (internal policy document)

At USQ we take this further by stating that to achieve in the higher education environment students require access to different types of knowledge, Knowledge about

- themselves as learners
- the cognitive demands of the academic task
- a wide variety of learning and thinking strategies
- content material [5]

These are linked strongly with the provision of academic numeracy and literacy concepts. Academic numeracy is defined as a critical awareness which allows the student to situate, interpret, critique, use and perhaps even create mathematics in context, in this case the academic context. It is more than being able to manipulate numbers or being able to succeed at mathematics [6]. In the higher education environment an independent learner needs to integrate academic numeracy and literacy concepts with self knowledge in order to master the academic situation of their choice. Mathematics support requires more than just doing the sums.

To achieve this providers of mathematics support offer a variety of programs as discussed above to cater to the specific needs of students. It is much more than fixing students up with the required knowledge or solving problems. Many mathematics support programs try to do more. In the words of Paolo Freire we try to help students grow from being problem solvers to problem posers moving well away from a deficit model of learning to a developmental one. But how can this be best achieved and acknowledged by students and university management alike.

Development of Mathematics Learning Support

Many mathematics support programs have been developed rapidly to suit the rapidly changing student and university needs. However, Keimig [7] suggests that consideration on the effect of the program on grade point average may be one way to measure the success of an effective program. She presents a decision guide for effective programs which includes a hierarchy of learning improvement programs that describes and ranks four types of programs: remedial courses, learning assistance to individuals, course related learning services and comprehensive learning systems (Figure 2)

Although evidence, especially from long term developmental bridging programs, suggests that some components of the hierarchy may not still be accurate today, Keimig's view on successful and unsuccessful programs may still be useful.

In a successful program the developmental concept is perceived as an institutional mission, and learning services are integrated into academic mainstream. The remedial program.....maintains a close working relationship with the academic areas of college or university.[7]

Less successful programs emphasize remedial courses and pre-college treatments, providing no systematic support services in academic courses...operating as an appendage outside college mainstream.[7]

Figure 2: The Hierarchy of Learning Improvement Programs from Keimig [7]

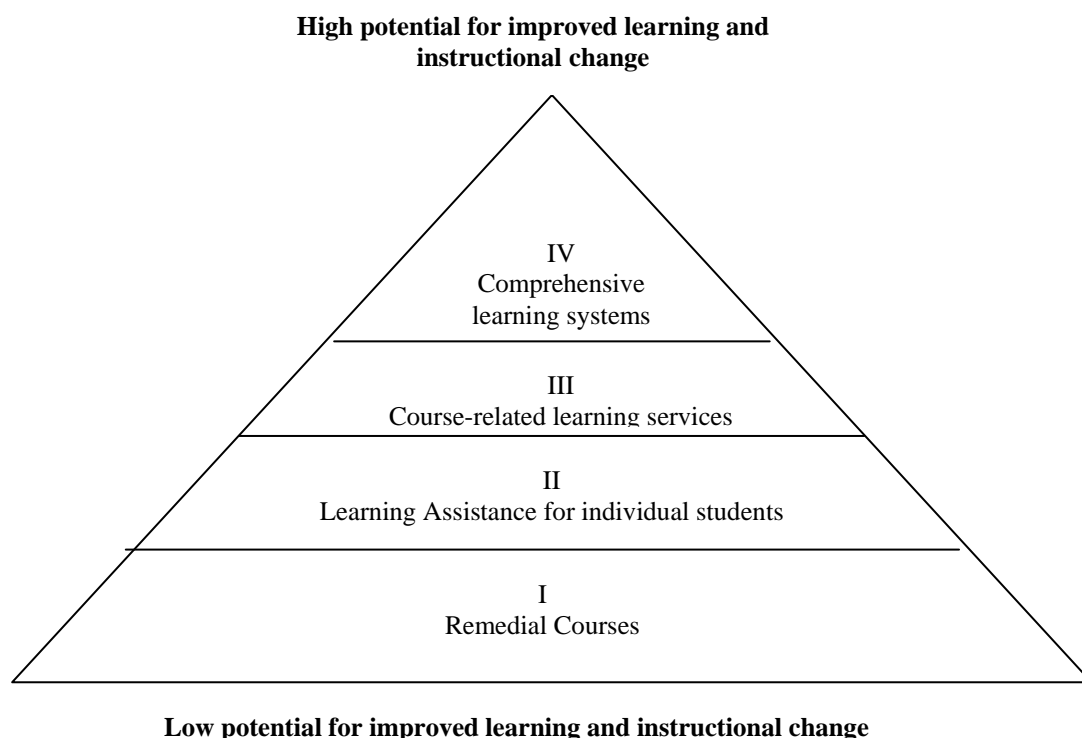


Table 3: Strategies of mathematics support offered at USQ in 1999.

Description	Students
Pre-Entry Programs	
Tertiary Preparation Program (TPP)	Equity bridging program, distance only (1000 students)
Foundation Skills	Continuing Education programs, distance only (40 students)
UNIPREP	Bridging program for overseas students (20 students)
Post-Entry Programs	
Learning Centre	
Drop-in Mathematics Support	All enrolled students (800 per year)
Residential school - Mathematics Support	External residential school students (40 per year)
1 st year statistics	All on and off campus students (2000)
Peer Assisted Learning Sessions	
Maths workshops, materials and testing	
1 st year mathematics (Algebra and Calculus)	All on and off campus students (300)
Mathematics support and testing	
1 st year Foundation Mathematics for associate degree	All on and off campus students (500)
Integrated curriculum	
1 st year Nursing	All on campus students (200)
Maths workshops, materials and testing	
1 st year Economics	All on and off campus students (2000)
Maths workshops, materials and testing	
Peer Assisted Learning Sessions	

*A range of flexible learning alternatives are used to deliver support to off campus students.

At USQ we have an integrated Academic Learning Support Strategy which addresses academic numeracy, literacy and self management. At this stage the academic numeracy or mathematics support are the most developed servicing approximately 3000 per year. The Office of Preparatory and Academic Learning Support is housed within an independent academic unit under the direct responsibility of the Deputy Vice Chancellor (Academic). Staff have developed a framework that allows both student centred and institutional perspectives to be considered in the development of a program. This framework involves the ranking of programs on a bivariate continuum which looks at program development from a student's and the institution perspective. This framework is still evolving but tries to consider the fact that just because a strategy involves a short contact with a student, as might occur in a Drop-in Centre, this does not mean that from a student's perspective they have not had a successful outcome. Student and institutional measures of success are often different. Using this framework we currently have a diverse and extensive system of support strategies (Table 3) designed to support students both on and off campus (USQ is a distance provider with 20000 students 75% of whom are study at a distance).

Conclusion

It is clear that as providers and users of mathematics support programs we have to consider future development carefully. Three things must be considered evaluation, promotion and research.

Keimig said in 1983 that 'the widespread use of inappropriate research design for program evaluation has tended to depress the outcomes demonstrated and to obscure the relative strengths and weaknesses of very different programs'. Godden and Pegg [8] warned in 1993 that traditional evaluation techniques employed in secondary and tertiary settings were not appropriate in bridging mathematics and encouraged evaluators to develop new evaluation strategies. Congos and Schoeps [9] do suggest a generalised strategy from the Supplemental Instruction literature that is worthy of consideration but it is often still difficult to implement because in many instances staff are so pressured by the task of designing, implementing and teaching new initiatives that no time or energy is left for the evaluation. Now is the time to encourage new joint initiatives involving mathematics support staff and experienced educational evaluators..

Once the pitfalls of evaluation have been overcome then promotion is the next step. It is not unusual to discover that members of mathematics departments know little or nothing about the mathematics support programs that operate in their universities, especially if they are outside that department. Management often know even less, even though issues of student retention are receiving high profile in senior management circles.

The needs of students drive mathematics support staff but in the long term we can only help those students by arming ourselves with convincing evaluation and research publications.

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