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Abstract

Students enter university with a variety of mathematical backgrounds. Some are not adequately prepared for the mathematics involved in their preferred, non-specialist mathematics courses. Many bring emotional conflicts about mathematics which affect their ability to learn. University of Wollongong recently appointed a Mathematics Support Lecturer to its Learning Development team whose role is to provide assistance to students who find the mathematics involved in their courses "challenging". This paper looks at the development of this role with emphasis on the requirement of mathematics to "synergise" with other courses, contexts and competencies within university studies and examines the broad cultural contexts of students seeking support and the issues - often affective and motivational - faced by students who seek support at this level.

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Synergising Mathematics Support Within a University Setting

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Students enter university with a variety of mathematical backgrounds. Some are not adequately prepared for the mathematics involved in their preferred, non-specialist mathematics courses. Many bring emotional conflicts about mathematics which affect their ability to learn. The University of Wollongong recently appointed a Mathematics Support Lecturer to its Learning Development team whose role is to provide assistance to students who find the mathematics involved in their courses “challenging”. This paper looks at the development of this role with emphasis on the requirement of mathematics to “synergise” with other courses, contexts and competencies within university studies and examines the broad cultural contexts of students seeking support and the issues – often affective and motivational – faced by students who seek support at this level.

Introduction

Students enter university with a wide variety of backgrounds in mathematics. Often these backgrounds are not strong, with some students having avoided studying mathematics as part of their final secondary school subject choices. Other students, although succeeding in mathematics at school, may have been out of formal education for a while and may perhaps have forgotten “fundamentals”. Students may encounter mathematics in many different courses in their university studies and many are surprised – even alarmed – by the need to pursue it again.

Moreover, students at any level of mathematics or statistics may occasionally – or more often – need help to overcome difficulties in the subject. Thus, there is a great need for assistance in mathematics or statistics topics across a range of faculties at university level (MacGillivray & Wilson 2008; Croft, Harrison & Robinson, 2009). MacGillivray and Wilson (2008) comment that mathematics and statistics support “is an area in which a small quantity of resources in the overall university scene can produce enormous dividends in student learning, confidence and fulfilment of potential” (p. E2).

At the University of Wollongong (UOW), a large regional university in New South Wales, Australia, support in mathematics and statistics was available from approximately 1993, through Learning Development (a section of the Academic Services Division) which provides assistance to students in academic language and literacies. In 1996, however, various institutional changes saw the lecturer transferring to the School of Mathematics and Applied Statistics and the position removed. The Learning Development section stayed without any mathematics or statistics support provision, apart from a little part-time assistance at one of the remote campuses, until research led to a fixed-term, contract position at the main campus being created and filled at the

beginning of 2011. Consequently, the position of Mathematics Support Lecturer in 2011 was regarded as “new”.

The focus of this paper is to look at the synergies created within the first twelve months of the position while attempting to develop a worthwhile, viable support system for students who need assistance with mathematics involved in their non-specialist mathematics courses. The challenges have been varied; the rewards worthwhile. These are discussed below, beginning with the challenges.

The Challenges

How to attract students?

A major challenge was to work out who the students were that needed and/or would benefit from this new support and where they might be found. What courses were they doing? Were there any courses where students needed help more than in other courses? What were their “educational biographies” (Schuetze & Slowey, 2002, p. 315), for example, what were their previous levels and experiences of mathematics education? And for what reasons would they seek assistance?

To address this challenge it was necessary to visit each faculty in turn, as well as certain schools within each faculty and to meet with appropriate representatives who would pass on information to relevant lecturers and their students. As no advertising had been set up, it was also necessary to develop promotional materials that would reach students. Further, there was the matter of determining the appropriate procedures and protocols to be followed. Although this challenge was time-consuming, it did, however, effectively begin the process of establishing synergy with faculty members and other university staff.

Developing this synergy with faculties and schools depended on the faculty or school involved. The School of Mathematics and Applied Statistics willingly encouraged students in first year non-specialist, or foundation specialist mathematics courses to use the service. By contrast, it appeared that personnel from some schools were reluctant to collaborate, or else the students themselves did not take up the support. Of course, this is unfortunate as several of these students may have benefitted from accessing support. The most attracted were lecturers in Primary Education and their students, many of whom had gained entry to that course without an “ideal” mathematics background; several School of Engineering and general science students also willingly participated as the service was readily promoted by their lecturers.

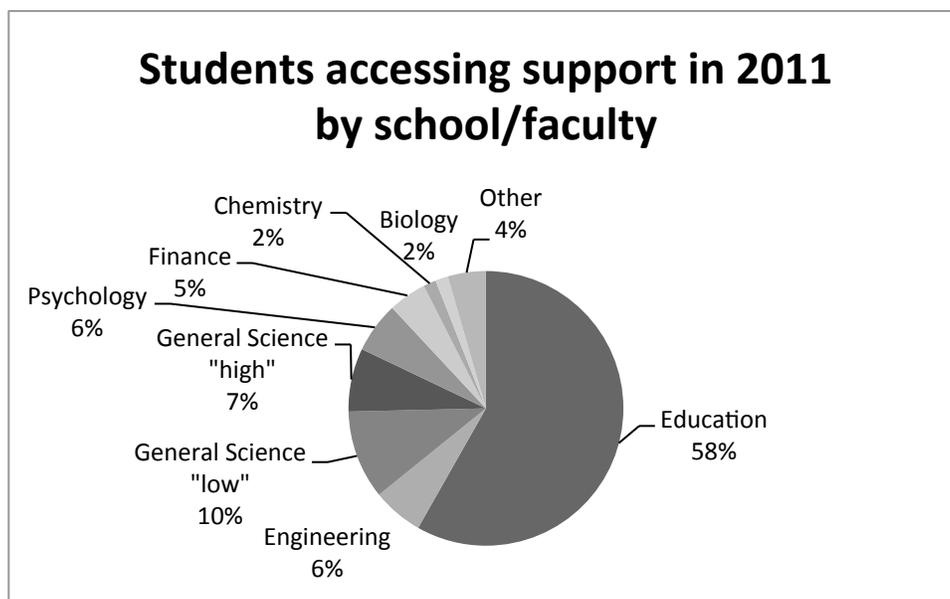
Thus it seemed that the development of synergies with faculties could be determined by the personnel involved. University school and faculty representatives need to see the work of Learning Development in a way that it is acceptable – in fact vital – that their students identify problems and seek to overcome them. One of UOW’s own aims, according to its website, is to produce graduates with certain “graduate qualities ... so that they can become informed and responsible and to be an independent learner, problem solver and effective communicator” (University of Wollongong, 2011). The website directs lecturers to the Learning Development section for help in incorporating strategies into their course procedures that will assist students to achieve these attributes. Until all academics realise that not all students have the same abilities and that support is absolutely essential for some of them to succeed in all subjects, however, Learning Development will need to continue to effectively promote its aims and the benefits of collaboration.

How would the support work?

Offers were made to lecturers in various disciplines for “team-teaching” procedures to take place with the idea that the Learning Development lecturer could teach the necessary mathematics in their courses as an embedded procedure; however, there was no uptake of this idea. This is disappointing, as with collaborative teaching, each teacher brings different expertise to the situation, such as in-depth pedagogical and discipline-content knowledge (Quinlan, 1998), and the opportunity for learning from each other by sharing experience and teaching styles can be beneficial as a “reciprocal learning process” (Zhou, Kim & Kerekes, 2011, p. 134). Perhaps staff felt that trust had not yet been established or perhaps they were not willing to dedicate time – or did not have sufficient time available in their heavy schedules – to work out a collaborative strategy (Zhou, Kim & Kerekes, 2011).

Some mid-semester workshops were developed that focussed on generic skills with the potential for them to be varied according to the specific needs of participating students; however, attendance at these workshops was poor. Thus the main focus of the support provision has been with one-to-one or small group consultations. Croft (2000), writing about the development of the successful mathematics learning support centre at Loughborough University (UK), concurs that this form of help is the most popular: “feedback from students shows that they appreciate this service most of all, and we have little doubt that if it were not available students would be less likely to use the Centre” (p. 437).

The graph below shows the percentages of students by subject areas who accessed the service in 2011; (subject areas have been combined within their schools or faculties)¹⁷. The graph especially illustrates the large proportion of Education students who used the support provision.



¹⁷ Both General Science courses are run by the School of Mathematics and Applied Statistics: “low” refers to a compulsory course for students such as those studying Environmental Science or Geology who do not have a background in calculus-based Mathematics; “high” refers to a mathematically more advanced course aimed at those possibly wishing to specialise in Mathematics or who may study Physics, for example. “Other” refers to students who accessed support once only, for example (but not exclusively) Medical Science students requiring assistance in interpreting the statistical results/analysis in a medical report.

In addition to the one-to-one support, the Faculty of Education, through the faculty's Student Support Advisor¹⁸, were keen to adopt the idea of a weekly lunchtime "drop-in" session. The mathematics support lecturer and the lecturer in Primary Education (Mathematics) had already established a firm synergy built on a shared vision of supporting students, together with a mutual trust and understanding. The first drop-in session proved so popular that it was decided to schedule two per week, with one a more formal session run by the course lecturer and the other a "Q & A"-type session, where students could bring their own questions and the group contribute ideas and discussion. All sessions of both types were well attended and this practice has continued, with the course lecturer adding a drop-in session to her course schedule. Most students who attended these drop-in sessions were studying the Graduate Diploma of Primary Education; and most did not seek further support through 1:1 or small-group consultations. It must be said that these drop-in sessions were also suggested to other schools and faculties, but the idea was not adopted.

What range of mathematics would be covered?

Faculty of Education students, in particular, have presented with a great array of problems, ranging from the primary school levels of mathematics that they will be required to teach, through to some pre-tertiary level concepts, which are given as course material mainly so that students become capable in, for example, reading statistical results, or other examples which will arise as part of their teaching duties. Students in other courses have requested review of lower secondary concepts through to advanced calculus topics. In fact, at times there has been demand for mathematics or statistics support by specialist Mathematics course students. Unfortunately, the current Learning Development lecturer does not have expertise in all requested topics and thus this has been seen as an equity issue for those students.

A further equity issue was that mathematics support was not initially available at all campuses; however, part-time assistance has now been organised and is available at the relevant remote campuses. Work is also in progress to develop resources to enable student access to support through internet and email procedures.

Student diversity

It is one thing to have attracted students, to have resources in place, to have determined how to deliver support and to have become familiar with the courses from which students are likely to seek help, yet it is certainly another thing to provide each individual student with the most appropriate support possible in order to ensure they are learning effectively and achieve their aims. Students present with a variety of reasons for seeking support: they will be of diverse backgrounds, ages, abilities, personalities; they will have followed any of several pathways into university; their cultural origins will vary, as will their learning styles and strategies, attitudes towards mathematics and their need to pursue support. For each of these students, "the focus of learning support tends to be on building mathematical fitness, confidence and transferability, all with reference to the specific course being taken" (MacGillivray & Wilson 2008, p. E13).

A student's level of confidence can be low or affected for a variety of reasons: it could be that they feel overwhelmed with the amount of work needed in their study; they may be unfamiliar with the particular topic being covered; perhaps they do not understand a concept and have never previously experienced this sense of not understanding; perhaps they did not enjoy mathematics at school and have set up a barrier towards learning it again; their background may not be strong

¹⁸ UOW Student Support Advisers offer liaison and information services to students.

because of various gaps in their schooling; they may themselves have experienced poor quality teaching in their own mathematics career, which has turned them against it; or as one student put it simply: “some people are good at things, some are not”. Further, some students may feel shame in needing to approach Learning Development and perhaps may even not come forward because of embarrassment. For many, “seeking help is associated with failure or loss of face” (Clegg, Bradley & Smith, 2006, p. 111). Thus synergy between the Learning Development lecturer and student is essential – only by developing a rapport with each student can one build their confidence which, in turn, helps the building of that “mathematical fitness” (MacGillivray & Wilson 2008, p. E13).

During the first twelve months of support availability, females outnumbered males (>3:1); there were only a few whose first language was not English and only one Indigenous Australian. Many of the students were employed as well as studying – often on a full-time basis. Most students were not in their first year of study, although some stated that they wished the Mathematics support had been available in previous years. Ages varied but students were, in the main, “mature-aged returners to study” rather than those who proceeded to university directly from school. This bears out the findings of Burton, Taylor, Dowling and Lawrence (2009) in their evaluation of mature-aged students’ learning strategies as compared to those of school-leavers. They comment that “mature-age students are typically conscientious and responsible, efficient, self-disciplined and organised, and have high aspirations for academic success. ... Mature-age intend to do well” (pp. 75-76). In fact, one particular mature-aged student’s decision was, in her words, “to be proactive” and to initiate help *before* she had problems.

Mathematics issues with which students have so far presented have ranged from higher-level mathematics and statistics to problems with basic computation – the latter students are possibly “dyscalculic” (Trott 2011). There have also been several students with varying degrees of mathematics anxiety (Taylor & Galligan, 2006), who regard their ability with mathematics in a very negative light and have little confidence of succeeding in their course because of their perceived lack of skills. Some of the Primary Education students are especially anxious about teaching the subject. Hodgen and Askew (2007), citing Buxton (1981) state: “for many primary teachers, their relationship with mathematics is fraught with anxiety and emotion, much of it relating to their negative experiences of school maths” (p. 469). Hodgen and Askew (2007) also express apprehension that many of this type of potential teacher may tend to oversimplify maths for their own students in order to “protect” them from it, with the possible outcome that their students will find mathematics tedious and “irrelevant” (p. 482). This is a real issue, as many of these students are hopeful of being allocated classes “with the little ones” as they believe that level will be “easier” to teach. But, as Bibby (2002) states: “if ... primary teachers’ subject knowledge is mediated by powerful feelings rooted in their autobiographies ... then this will impact on the ways in which that knowledge is used professionally in the classroom” (p. 706). Bibby also links the concept of “shame” to some teachers, where “feelings of shame include threat to ‘professional identity’ as well as ‘personal and social aspects of identity’” (p. 708). Thus synergy is absolutely involved in supporting students such as this: a great deal of working with them to instil confidence in their ability, of guiding them to discover that they indeed *can* do maths, and that mathematics is definitely relevant, not only to their teaching profession, but, of course, in their own “everyday lives”.

Other students bring with them a variety of problems. In some cases this has prompted the need for negotiated collaborative support through different agencies such as the Counselling and Disabilities units; in turn, these units also often refer students to Learning Development.

Students may take very different amounts of time for support to be effective. Several students have used their consultations as “one-offs” to iron out a lingering problem they have not been able to solve through “normal channels” (lecturer, tutor, fellow students, for example); others attended for the full year. It is absolutely necessary to distinguish between those who use the service more as a crutch and those who are in genuine need of support, however, and to try to encourage all to become efficient, successful, independent learners.

Of course there will be some students who do *not* attend Learning Development. This may be because they have many commitments outside university and possibly consider Learning Development support as an extra obligation in their already-too-busy schedule. Others may find support given by their lecturers, tutors, peers, or other means, sufficient for them. Possibly some students feel all right about their mathematics even though their results might demonstrate otherwise. Others, however, may feel embarrassment or shame and a feeling of failure at needing support, or have perhaps organised their own means of coping (Clegg, Bradley & Smith, 2006, p. 112). As the availability of support becomes more widely known and is advertised by word-of-mouth, it is hoped that these students may feel more comfortable about attending.

Developing resources

Learning Development soon accumulated a professional Mathematics library with the purchase of several relevant Mathematics books. Many lecturers in various schools and faculties, especially the school of Mathematics and Applied Statistics and the Faculty of Education, were exceptionally generous both with their time and also in providing the support lecturer with access to printed and electronic material appropriate for their students.

Consideration was given to purchasing a tablet PC for use in Learning Development and a project was undertaken exploring its viability. A 2007 model was given on loan from the School of Mathematics and Applied Statistics, which was used mainly for developing resources rather than during 1:1 consultations because, unfortunately, it was found that there was inadequate provision of storage or software capabilities whereby the student could take any part of the session away with them for review, which is an extremely important part of the learning process. This is disappointing because, as Loch, Galligan, Hobohm and McDonald (2011) point out, the portability of tablets is a distinct advantage, especially for revision, practice and reflection: if the screen- and voice-capture technology of a tablet PC is used together with annotations using the stylus, the student can take away a complete recording of their support session to which they may refer in their own time later, if necessary¹⁹.

Early on in the tenure of the position, it was seen that students lacking the more basic mathematical concepts – for some reason or other – were not necessarily catered for by resources previously developed by the University. Therefore it was decided to embark on a project aimed at developing interactive web-based resources for the most common topics that students accessing the support required. These resources need to be user-friendly, and be aimed very much at the more “maths-anxious” students. The agreement governing the project was not reached easily, however. There is a definite need for university personnel to understand the reason that basic mathematics resources are needed at university level: that, for example, the range of students now is greatly diverse and, especially, that the requirements for entry to

¹⁹ By the time of the ALM Conference, a laptop tablet PC had been purchased by Learning Development. Investigations are underway looking at the problems outlined.

courses are no longer bound by success in particular school-based mathematics. MacGillivray and Wilson (2008) argue that:

Universities need to guard against the dogma of denial of the importance of mathematics, and ensure that the totality of help for their students in numeracy, mathematics and statistics is espoused and sustained. ... Learning Support in mathematics and statistics has become an increasingly important component in this totality, building individual confidence and repairing weaknesses (p. 33).

Put quite simply, if background knowledge is missing, students do not have adequate means to pass their course.

To this end, as well, several print-based resources have been developed on each topic necessary for students requiring support at a “basic” level. They are aimed specifically at adult, maths-anxious students and incorporate a great deal of explanation about the relevance of each topic. The resources, soon to be accessible through the Learning Development website, are now situated within the Learning Development unit, which is situated in a non-prominent position within the university, thus reducing embarrassment a student may feel about being seen taking such resources, although this placement does have the disadvantage that the resources may be difficult for students to locate.

To assess or not to assess?

In the relatively short life of mathematics support availability at UOW, lecturers from some schools and faculties have been keen to adopt diagnostic testing. They argue that, in order to recommend to students that they will need extra support, they must be able to back such a recommendation with evidence gained from assessment. Such diagnostic procedures can be demeaning to many students (Clegg, Bradley & Smith, 2006, p. 112) by emphasising yet again the inadequacies of their mathematical skills; by the time they reach university, students know their weaknesses. Further, “the act of being assessed is one that has considerable emotional resonance” (Boud & Falchikov 2006, p. 406).

Therefore it was decided that the support lecturer write a diagnostic test that catered particularly to such students. Following the methods of Galligan (2011); Price, Stacey, Steinle, Chick, and Gvozdenko (2009); and Egea (2004), a model was written which would not only give the student a hint of a means of working out answers to problems posed (through supplying method answers for each set of choices) but also required them to rate how confident they felt for each topic. Importantly, the test had no time limit. For incorrect answers, separate explanations were supplied which would indicate to the assessor the reasons that those answers were incorrect. It was very disappointing to discover that this model was rejected by the particular school for which it had been written. It is hoped that the school – and others – will, however, use the model as a self-diagnosis for their students.

The challenge of whether or not to use diagnostic testing may perhaps be seen as evidence that some lecturers consider these students as fitting a “deficit” model. Cole, reviewing Hartley, Hilsdon, Keenan, Sinfield and Verity’s (2011) book *Learning Development in Higher Education*, suggests that educational institutions may still see Learning Development as ““institutional first aid”” and that the use of such terms as “‘diagnose’, [and] ‘intervene’ ... imply that the agency is still not with the student, which undermines the notion of the independent learner” (p. 6). Further, Black and Yasukawa (2011) suggest that ““deficit thinking’ ...amounts essentially to the process of ‘blaming the victim’” and add that “one of the significant outcomes of deficit

approaches ... is the negative and sometimes debilitating effects they can have on people's self-image, their identities" (p. 3).

The equity issue

One of the concerns for Learning Development is that of providing equitable support – that is, of course, support for any student who needs it. For this to be possible, the present lecturer could be joined by specialists such as those who can confidently teach further topics of each of mathematics and statistics. Funding administrators need to be convinced of this, with the present Mathematics Support position seen as a starting point only. As MacGillivray (2009) reports: “students who choose to specialize [sic] in mathematics and/or statistics are as likely to access this learning support as much as non-specialists” (p. 458).

Croft, Harrison and Robinson (2009) use the term “*holistic*” to describe their “vision of mathematics support” and recommend that “help needs to be available *when* students need it and from staff who are well-suited to provide it” (p. 113). Currently at UOW, support is provided by course lecturers in their consultation times and, for some courses, by Peer Assisted Study Sessions (PASS). Not all students are comfortable in either setting, however, as “seeking help is somehow associated with failure or loss of face” (Clegg, Bradley & Smith, 2006, p. 111). In fact, one mathematics lecturer reported to the support lecturer that she had been “underwhelmed” by student attendance during her consultation hours. Perhaps these students may benefit from the more anonymous support provided by Learning Development.

By contrast, in 2011, the first tier of a program entitled *Successful Transitions* was implemented by Learning Development. This series of seminars runs at remote campuses between Orientation Day and the commencement of the academic year. It is aimed at new enrolling students, introducing them to certain strategies that they will need at university but with which they may not yet be familiar. The program was very well-received by both staff and students. In 2012, a component called *Mathematics: Marvellous or mystifying* was run as part of the *Successful Transitions* program, in which students were asked to analyse their feelings towards Mathematics with the aim of challenging them to realise that they do indeed possess – and regularly use – mathematical skills and, especially, problem-solving skills. As well, it aimed to confirm to them that if they felt inadequate or anxious about mathematics, then they certainly were not alone. By introducing the mathematics support lecturers at each campus, the program sought to reassure students that support and assistance is available should they need it and that it is definitely acceptable to seek such support. This program is seen as part of an equity program and is funded by a Social Inclusion grant. Its aim is to target, reach and support an increasingly diverse cohort of students such as rural, remote, Indigenous, or mature-aged; however, as Burton, Taylor, Dowling and Lawrence (2009) put it, “acknowledging diversity is one thing – achieving inclusiveness is another” (p. 78).

Retention of students

It is hoped that the work of Mathematics support through Learning Development will be seen as more than simply a means of enabling greater retention of students. However, this seems to be an aim for universities in general, and implies that economic aims, not educational aims or the aims of individual students drive the financing of such support. Students themselves, with the assistance of professional guidance, must make their own decision whether or not to stay on at university. All circumstances should be taken into account, including, but not exclusively, potential failure.

MacGillivray and Croft (2011) suggest that “a university’s approach to retention should be a positive one and ... it should provide students with opportunities to improve their grades rather than just addressing gaps within their knowledge” (p. 201). As suggested previously, this is in line with UOW’s mission of Graduate Qualities. Mathematics support through Learning Development must be for the benefit of each student even if, in the long term, that student decides not to continue their university course – the outcome obtained may be as simple as that student developing a more positive attitude about mathematics that they may carry into the community.

The Rewards

“Success”?

Although this topic has been mentioned under the heading *Rewards*, it actually brings with it a further challenge! Yes, there has been “success” – students have passed their courses who may perhaps otherwise not have done so. The challenge is, of course, to determine just how much influence the support had in students obtaining these results. MacGillivray and Croft (2011) suggest that it is worthwhile collecting qualitative data from students; for this purpose, a short evaluation form was emailed to students at the end of the year. Unfortunately not many replies were received, however all responses acknowledged satisfaction with the support received and students felt it had helped in their studies. This could be supported by quantitative data (obtained from faculties) which might show, for example, improvements in course outcomes. Even with substantial data, however, causality cannot be implied! Cole (2011), in fact, suggests that for Learning Development, this is the “biggest challenge: ... determining what kinds of data will best illustrate impact and identifying ways in which it can fund such evaluation and analysis” (p. 6).

Further, “success” may mean different things to different people – for the student, it may be as simple as being able to apply a mathematical concept with understanding, although, of course, in general most would probably acknowledge that their aim is to pass their course! For the university administration, “success” may mean that a student will eventually graduate – and become a “success statistic”. For the mathematics support lecturer, it can be the emotion felt on seeing that a student understands, retains that understanding of, and can apply a concept about which they had asked for help. The words: “now I see!” said by one individual student have more meaning than any set of crunched numbers! The problem is, of course, that for the support lecturer’s position to be maintained, statistics which *prove* – or at least *imply* “success” must be produced.

Conclusion

This synergy of mathematics support within a university setting can be seen to have involved, and to continue to involve, a great many collaborations between the mathematics support lecturer and students, faculties and colleagues. Further synergy has grown through communication with fellow external university lecturers who have given expert advice and assistance – this has been particularly valuable in the setting up of the position and resources. As well, a valuable synergy has grown through the opportunity to participate in some research and other projects. However, by far the main synergy has been found in working with a diverse range of students, the majority of whom are hard-working, dedicated, and possess “I-won’t-let-this-subject-beat-me!” attitudes.

UOW's Learning Development *mission statement* includes the following: "To develop synergies between teaching, governance, professional development and research as they relate to improving and facilitating student learning, the acquisition of academic literacies, the acquisition of discipline appropriate English language, and numeric thinking", (*Learning Development Policy and Procedures Manual (2011)*). Developing and maintaining these synergies is vital for the success of all students in their venture to become professional graduates who exhibit UOW's Graduate Qualities. It is through these synergies that more than the sum of the parts can be achieved.

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