

Bridging the Gap for First Year Students with the Use of Peer Tutoring*

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First year mathematics and statistics classes generally do not accommodate to the range of technical abilities which students have when they enter into first year university. UTS offers extra support for first year students by the use of a Mathematics and ICT Study Centre. This resource is available for students from a variety of faculties, who study or use Mathematics in their degree. A peer tutoring service has been implemented in the study centre with volunteer students from third year mathematics and statistics classes being rostered, simultaneously bridging the gap in the budget and the students' education. This paper describes a study which used qualitative methods to examine the motives and benefits that have opened up for the student tutors through peer tutoring.

Peer tutoring is defined as students taking on the role of a teacher to other students of either the same academic level or lower. It is important because it has great potential in the development of students' skills both educationally and personally.

Much work has been done on looking at the benefits of peer education as a whole and of different aspects of peer education. Damon and Phelps (1989) distinguish three approaches to peer education namely peer tutoring, cooperative learning and peer collaboration. Cooperative learning is generally a team based learning approach where students pool their resources together on a particular topic and in peer collaboration simultaneously approach all aspects of a topic, constantly working together. With these two aspects of peer education, the students are generally on an equal level to one another whereas in peer tutoring, one student takes on the role of a tutor and the other(s) take the role of a tutee. Griffin & Griffin (1998) investigated the positive effects of reciprocal peer tutoring on various educational levels. They found that peer tutoring is effective at increasing student achievement for both the tutor and the tutee with the tutor often benefiting more than the tutee. Peer tutoring schemes have been implemented in a variety of subjects and educational levels. Carroll (1996) discusses the effectiveness of senior medical students acting as co-tutors working in tandem to the academic tutor for first year biology students and Bush (1985) describes a peer tutoring program used for introductory accounting courses as a possible suitable substitute to current laboratory classes. In both of these cases the senior students were paid as academic tutors and were able to relieve full time academic staff while at the same time providing quality tuition to first year tertiary students.

Peer tutoring has benefits not only for the tutee but also for the tutor as a means of promoting educational and personal development. Both Hopkin (1988) and Houston & Lazenbatt (1999) investigate the use of reciprocal peer tutoring within a class environment at a tertiary level where each student (or group of students) in the class is responsible for a particular topic and then take on the role of the tutor, teaching that particular topic to the other students in the class. They found that this type of peer tutoring fostered independent and responsible learning, promoted greater levels of communication, student participation and a deeper understanding of the work involved (mathematically in Hopkin and educationally in Houston & Lazenbatt) for the tutors.

This paper describes a study of a peer tutoring program where senior students voluntarily take on the role of an academic tutor for first year mathematics students. Unlike the other papers discussed, this study used qualitative analysis of the use of peer tutoring from senior students who were volunteering their time and efforts, not for financial gain or means of passing a subject, but rather as a genuine commitment to the further development of mathematics for themselves and others. We shall describe the different approaches the tutors took in teaching mathematics, their reasons for volunteering, accomplishments achieved and any connections between them, how their views on learning mathematics and mathematics in general have changed since tutoring, and look into the different approaches to and depths of their own mathematics and how the peer tutors' responses reflect these. This paper is important because it confirms the belief that positive benefits are gained through peer tutoring while exploring a new realm of what is possible within this tutoring system.

Background

The transition for students from secondary school to tertiary education involves major changes not only academically, but also socially and environmentally. At the University of Technology, Sydney (UTS) there is a mathematics study 'drop-in' centre where students come and receive support from tutors. It is also commonly used as a meeting place for collaborative learning where students do group work and often receive support from other students. This form of social academic interaction has helped make the transition less stressful for the first year students.

Mathematical support for first year students is available in universities through a variety of means. There are standard tutorial and laboratory classes, some subjects implement extra support tutorials and students can also visit lecturers for extra support when needed. At UTS there is also the operation of a Mathematics and ICT (information and communications technology) study centre. The operations of the study centre include the running of support tutorials, workshops, bridging courses as well as the drop in centre where a tutor is available to give support for first year students requiring help in mathematics, statistics and introductory computing. There are four computers in the drop in centre which enable students to receive assistance in using the mathematical and statistical programs. Throughout the past few years the study centre has been a popular environment for mathematics and statistics students from a range of faculties. They visit the centre for assistance and extra support. It also became popular in its use as a meeting place for collaborative learning.

Peer tutoring program

Traditionally at UTS, honours and doctorate students have been paid to act as peer tutors in the Mathematics and ICT drop in study centre. Last year the implementation of a peer tutoring service, in which third year volunteer students were added onto the tutoring roster, was incorporated into the drop-in study centre. In the semester just passed (Autumn, 2005) the tutors consisted of one doctorate student, three honours students, one full-time staff member/researcher as supervisor and 18 third year volunteer students. This has shown to be highly effective among the first year students, the tutors (third year volunteer students and honours students) and also on the budget, making it a win-win situation for all involved.

The requirement for the volunteer tutors was that they were each to tutor in the drop in study centre for one hour every lecturing week, with their choice of tutoring during the non-lecturing weeks, whereas the paid tutors were in the centre every week. The volunteer tutors could either do this hour on their own or pair up with another volunteer and share a two-hour shift between them. There was no minimum academic achievement result required for the students to volunteer as a tutor as there were always other resources available for the tutors if they did not feel confident in answering a particular question asked by a student. Emphasis was placed on the tutors' responsibility and communication for the successful operation of the drop in study centre. If a tutor could not make his or her shift for any reason it was requested that they attempt to swap a shift with another student for that week and if they were unable to do so that they be in communication with the supervisor who would try and find a replacement or post a notice of their absence.

Towards the end of semester the tutors were asked to complete a survey on their learning experiences while assisting in the study centre. The survey was designed to address the nature of teaching in the drop in study centre, the experience gained by the tutors and to gain an insight into peer tutors' different points of views for the learning and teaching of mathematics at an introductory tertiary level. In addition to demographic questions, the following questions were asked:

- Why did you originally volunteer or sign on for peer tutoring?
- How do you go about teaching mathematics in the maths study centre?
- What are your views of mathematics and how have they changed since tutoring?
- What are your views on learning mathematics and how have they changed since tutoring?
- What sense of accomplishment do you feel you have gained through peer tutoring?

The survey was not compulsory and out of the 22 peer tutors in the study centre (other than myself) there were 12 responses. Of those students, nine were third year volunteers and three were paid honours students. The details of the students participating in the survey are shown in Table 1.

Table 1. Students in Survey

Student Reference	Degree	Year
A	B. Maths and Finance	3 rd
B	B. Maths and Finance	3 rd
C	B. Maths and Finance (Honours)	4 th
D	B. Maths and Finance	3 rd
E	B. Maths and Finance	3 rd
F	B. Science in Maths	3 rd
G	B. Maths and Finance	3 rd
H	B. Maths and Finance	3 rd
I	B. Maths and Finance	3 rd
J	B. Science in Maths (Honours)	4 th
K	B. Science in Maths (Honours)	4 th
L	B. Maths and Finance	3 rd

Methods of teaching

The tutors used a wide variety of methods and resources when teaching in the maths study centre. Some of the tutors explained the theory and concepts involved behind the questions, as seen by [G] and [H] (below) taking a deeper approach to teaching, while others used examples and explained the steps involved to show how to tackle problems in a more systematic manner as seen by [L]. Sometimes these differences in approach were due to how much the tutors felt the students understood or wanted to know, for example [J] and [K].

[G] ...I try to give them an overview of the basics to ensure that they aren't just learning how to do the question.

[H] I tried to clarify what sort of explanation/help they really require and explain things in the simplest way I can.

[L] I attempt the question by myself first and when I get an answer I show the student how I reached that answer. I clearly explain what I did in each step and make sure that they understand the method.

[J] ...more times than not its just that they want help in doing a single problem or it's an assignment problem. It's not often at all that someone will walk up and say 'hey I don't get integration by parts can you help me review it?'

[K] I read the question and ask them what it is they don't understand about it, then I teach them the concept or the topic they are confused with, and after that if they still have trouble doing that particular question, I give them an example similar to that question, and usually at this stage they can do the question on their own

Many questions required a unique modelling approach rather than a systematic manner of teaching, such as some science or worded questions. Some peer tutors found it challenging to get these types of questions across to the students, for example [C], [I] and [J] (below). When difficulties were encountered in explaining the work the tutors used a variety of different resources. All of the tutors incorporated other resources into their teaching in some way or another, such as looking up topics from the students' textbook or textbooks in the centre, incorporating the assistance of fellow peers in the centre at the time and when all else fails, requesting the assistance of a lecturer [F] was always an option. The peer tutors also asked the students requiring assistance what they knew about the topic as both a resource for the tutors, and a solidification of the student's knowledge, as seen by [I] and [J]. There was a great emphasis on communication between the peer tutors and students while teaching. Much of the communication from the students to the tutors seemed just as important for their understanding of the work [J] as from the tutors to the students, helping to solidify the students' knowledge at the same time as having them feel comfortable to ask the questions [B].

[C] ...it is not very easy to explain maths to students. Well I do what I can, drawing a diagram or graphs is often helpful...

[I] We may have never seen the application of maths with regard to some engineering and finance students, or it may have been years since we had dealt with a topic. So in working with the student we need them to tell us everything they know and maybe to isolate textbook material. This process is often times as important to the solidification of the student's understanding as are the links and explanations that the tutor can offer.

[J] I Try to think about the best way to explain what it is happening in the question in a pseudo mathematical way (important for word questions). If I don't know I ask to see the textbook and work over that section with them. Or I try to think though the problems from scratch with some help from them ... I then try to walk them though it with them prompting me on what to do or I ask them questions on what should happen next

[F] If I can answer it straight away, then I do, if not I look for a friend in the MSC at that time who could help. I have also called a friend on the phone to help me. If I feel there is no way that I can help, I suggest the student visit their lecturer, or direct them to a lecturer that I know will be able to help.

[B] I would also try to develop a friendship between students so as for them to feel comfortable asking questions and being honest with what they do and don't understand.

Views on mathematics and learning mathematics

Different views of mathematics are apparent through the peer tutors' responses. We have defined three main levels in which people view mathematics. A lower level view of mathematics is that it is a tool used for calculating things. A mid level view starts to see mathematics in an abstract or analytical way, as well as seeing how it can be used in modelling real life situations. The highest level of viewing mathematics is that everything in life can be described by mathematics. Students who view mathematics on a lower level often take a surface approach to learning how to do maths, often by rote learning. Students who view mathematics on a mid and higher level usually foster a deeper approach to learning mathematics as they go beyond seeing it as just a tool and consider how it relates to life in a modelling sense, and analytically how it starts to relate to itself, as an abstract language. Students who didn't understand the work on a deeper level would be more likely to struggle to follow topics [B-1] (see below). Most of the peer tutors had a mid or high level view of mathematics. A high level view can be seen in [B-2] and [L]. In [D] it is seen in the practical sense but not very deep in the analytical sense. Most of the tutors viewed mathematics and learning mathematics as challenging [B-2], [D], and interesting [G].

[B-1] ...there is a core requirement for understanding mathematics which is basic understanding and this is one thing I discovered whilst tutoring. Students who missed one core fact of a topic would have trouble understanding everything related.

[B-2] I have always viewed Mathematics as a fundamental subject to education which can be very challenging and thus requiring logical and analytical thinking. I believe maths exists in all areas of life and even in more subtle situations like decision making which seems maths free but also requires analytical thinking.

[L] I believe that mathematics is one of the most important subjects. It is incorporated into almost everything around us.

[D] ... it is helpful in the real world, but the depths of it are just useful if you are an insightful person or just love maths. It is very challenging and logical...

[G] Mathematics is an exciting area of study with a lot of interesting applications. Tutoring in the MSC has made me even more appreciative of these applications and areas of study.

At times, some of the tutors disliked maths or found it boring. It can be seen in the following two quotes that at those times a surface approach to learning was most probably taken, they have not fully understood what was going on and have more than likely made it through those situations by rote learning the components.

[A] There are topics I feel are boring and complicated and confusing, these I find hardest to learn because of inability to understand fully. I feel that some of those topics are 'pointless', but still try my best to learn them because I don't want to fail.

[D] Maths is fun when it is easy, but I dislike it when it gets into physics and very scientific.

The comments below indicate that some of the tutors have developed a higher level view of mathematics, through a greater understanding, since they started the peer tutoring program. However, a few of the tutors' views of mathematics have not changed since tutoring. By teaching other students, some have developed a greater appreciation of the practicality of maths [D], a greater understanding of the methodology used in applications [B] and insights in seeing how mathematics plays a fundamental role in real life situations [K]. Since teaching, some tutors also gained a greater analytical understanding of the underlying theory [J]. Overall, the peer tutors have fostered a deeper level of understanding of mathematics.

[D] ... since tutoring I noticed how [much] more practical maths is.

[B] ...through tutoring I have come to understand that more importance should be placed on methodology and understanding than purely repetition.

[K] By tutoring other students, you can get the overall picture of the topic in mathematics that you have taught, and clearly you can see what sort of problem you are solving, and [how] they might be used in the workplace.

[J] When you first do it, you are more thinking about the mechanics of the problem as in we do this then that when it looks like this. But now when I look back at that work it seems to make more sense.

It is said in Damon (1984) that the students have more to gain in learning from their own age group in addition to that of the school teachers, as they are direct in their communication and on a level easily understood. A similar view is shared by some of the peer tutors, seen by [F] for example, thus indicating that the peer tutoring program is a win-win situation for all involved [I].

[F] A lecturer knows their stuff inside out, back to front, and has the answer before you have read the question. A student tutor, however, has a quality that the lecturer has lost and will never regain. The student tutor can teach short cuts to learning and understanding concepts on a much more basic and willingly absorbable level.

[I] If you can teach something then it's a sure way to learn it good. I see a lot of students in the study centre get onto this fact and jump at the opportunity to get involved in tutoring.

Reasons for volunteering and accomplishments achieved.

The reasons why students volunteered or signed on for peer tutoring can be divided in two categories, extrinsic and intrinsic. Extrinsic reasons include the opportunity to help younger students, share knowledge, to take the pressure off other tutors, to put something back into the mathematics department and into the university community.

[K] When I was in 1st year I noticed the Maths Study Centre was helpful to me. That is why I wanted to help students with the extra little bit of help they might need in order to do well in their subject.

Different intrinsic reasons include filling time in between classes, gain some teaching experience, a nice addition to the resume, solidify knowledge, increase communication and interpersonal skills, increase confidence, meet more people, learn from the students and the self satisfaction of teaching enjoyment. This last point could possibly be viewed as extrinsic in its origination, as it is more than likely the tutor gains such enjoyment through making a difference for other students. We shall look at this again through the peer tutors' accomplishments.

After the peer tutoring program all of the tutors who responded to the survey said that they felt a sense of accomplishment. Extrinsic accomplishments were all based around being able to help contribute to other students' knowledge and understanding of mathematics and inspire them for future study. Intrinsic accomplishments gained by the tutors included having developed some new friendships, a greater sense of responsibility, an increase in or grounding of their own mathematical knowledge and the development of other skills such as interpersonal skills and the ability to convey knowledge to others. Some also said it had increased their levels of self confidence, in tackling unknown problems and they had rediscovered their overall confidence in mathematics. The most prevalent of the accomplishments is intrinsic in nature with extrinsic origins in that the tutors felt good about themselves by helping make a difference to others. This accomplishment is often a direct link to the reason why people have an enjoyment in teaching. It also plays a significant role in the outcome of the other intrinsic achievements, as seen by example in the following two quotes.

[F] When I have helped just only a hint, enough for them to recognize the rest of the problem on their own, it gives me such a boost of confidence, motivation and inspiration, that my own study becomes a pleasure.

[H] ...the satisfaction of successfully helping others impacted greatly on my self-confidence.

Only a few of the peer tutors knew that they enjoyed teaching when they originally signed on for volunteering in the centre, however, nearly all of the respondents expressed experiencing pride and enjoyment from their teaching in the peer tutoring program. This is illustrated by the following quotes.

[A] I feel good when I am able to provide help to other students. ... Seeing students who have a better understanding after my help is most rewarding.

[C] Well, it always feels good when you find that you've been helpful to some people. And yeah, it kinda gives me pride to hear that students have got good marks thanks to my teaching.

[D] It feels great when you successfully help a student with their maths. It's the concept of 'giving yourself a pat on the back'.

[G] It is great to see that you can make a difference to a student. When they go away with extra knowledge and a smile on their face, you are left with a feeling of achievement.

[I] I get a real kick out of helping students out.

[L] I've always found it very rewarding to help others in need.

An overall accomplishment brought forth through the achievements of communication and interpersonal skills, friendships developed and responsibilities gained, is that a greater sense of community was realised among the peer tutors.

Conclusion

This paper has described a peer tutoring program to support first year students who study mathematics or statistics in their degree. Research has shown that peer tutoring has much to offer students, benefiting both the tutors and the tutees. Volunteer students have worked as peer tutors in the Mathematics and ICT study centre, bridging the gap financially and educationally, in what can be described as a "successful" operation.

Many first year students frequented the drop in study centre to utilize the tuition of the peer tutors. A survey was completed by the tutors and a qualitative analysis of their responses was performed. Of the nine from eighteen volunteer students who completed the survey, all claimed the program had fostered a deeper level of understanding of mathematics and many of them gained confidence in themselves personally, or in mathematics over the course of the program. It could be argued that the nine volunteers who did not complete the survey did not benefit from the operation. The survey however was not compulsory and was distributed only a few weeks before the commencement of exams and they may simply have chosen not to complete it due to being busy in the preparation of their final exams. Overall, we are assured that at least 50 percent of the volunteer tutors did have a positive experience in the program.

The third year student volunteers did not have anything to gain financially over the course of the program. This gives a sense of reassurance with the quality of teaching as the volunteers were not simply going through the motions of a job but rather they held a genuine commitment to furthering the development of mathematics for themselves and others.

This study has confirmed our belief of positive benefits gained through peer tutoring and explored the possibilities of its potential. The Mathematics and ICT study centre will continue to incorporate senior student volunteers into the peer tutoring program in the future while taking on board the tutors' suggestions for improvement to ensure the continuation of a "successful" operation. With the close to negligible operational costs, positive benefits gained by the tutors and quality reassurance in teaching to visiting first year students, this peer tutoring program has shown to be a win-win situation for all responding tutors.

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