Peer support assisted through anchored discussion forums

Final Report for IATL funded pedagogic intervention

Background – The transition into tertiary level mathematics

Challenges in the secondary-tertiary transition in mathematics are well documented in the literature. In 1995 the London Mathematical Society published a report in which it expressed concern about the mathematical preparedness of these students (London Mathematical Society, 1995). More specifically, the report identified the following issues in the mathematical background of new undergraduates:

- a lack of technical competency, i.e. the fluency and reliability with which students perform algebraic and numerical manipulations;
- a lack in problem-solving skills, particularly when faced with multi-step problems;
- a lack of appreciation of the nature of mathematics and its reliance on precision, logical deduction and rigorous proof.

Grove (2012) gives an overview on recent developments since the LMS report but points out that the issue of mathematical under-preparedness persists. Furthermore, as discussed in Daskalogianni and Simpson (2002), the discrepancy between what students encountered in mathematics at school and what they are exposed to at university leads to a "cooling off", a loss of enthusiasm for the subject and subsequent disengagement.

Lawson (2015) describes some of the subject-specific factors that make the secondary-tertiary transition particularly challenging in mathematics. A-levels in the subjects Mathematics and Further Mathematics have the highest proportion of both A* and A grades amongst all subjects. This might be due to a selection effect of the cohort taking A-levels in these subjects but Lawson (2015) also suggests that the nature of mathematics taught at A-level is a strong contributing factor. The emphasis is on procedural precision in routine mathematical problems, thus good assessment results can be achieved by rote learning rather than being reliant on a deep understanding of the relevant processes and concepts. This leads to a frequent affirmation of ability, albeit being mainly an outcome of (false) fluency, and thus may encourage students to consider further study of mathematics even though they may not foster a deep interest in the discipline (Lawson, 2015).

Not surprisingly many first year students in our department also struggle with the transition to university level mathematics. In particular we identified the following issues:

- The recall of content from lectures can be weak, and is often coupled with the central role of definitions not being appreciated. The mathematical definition of a concept is the precise statement of what constitutes an instance of the concept. Instead of using concept definitions, students argue using concept images, that is, mental images they formed of the concepts by considering example instances rather than the definition.

Amongst first year students concept images are often vague, incomplete or based on misconceptions yet, as Clark and Lovric (2009) point out, such synthetic models can be very resistant to change.

- Students struggle with the correct use of terminology and notation. Their use of notation often is characterized by an instrumental approach based on manipulation rather than an understanding of the underlying concepts. This makes it more difficult for them to understand definitions and propositions and it also affects their ability to ask precise questions, to contribute in discussions and to understand explanations given.
- Students may feel uncertain about their own progress and level of understanding. They may also lack perseverance when faced with unfamiliar problems.

Rationale

Mathematical discussion, the exploration of mathematical concepts and methods, asking questions and finding solutions are vital ingredients of learning in undergraduate mathematics. However, in particular in the first year, it is not an uncommon experience to find that students hesitate to ask questions and take part in discussions. This may be because students feel concerned about appearing less competent and about asking 'stupid' questions. Also, a substantial proportion of undergraduate students in the department are from overseas and thus, in addition to language barriers, may be less used to conversational models of teaching and learning.

The aims of this project were two-fold. Firstly, it explored the use of peer tutoring as a means to help students with the secondary-tertiary transition. Secondly it trialled the use of anchored online discussion forums as another means of providing support to first year students. The peer tutoring took place in term 1 as part of the module ST116 Mathematical Techniques. The discussion forums were trialled as part of ST116 Mathematical Techniques And ST104 Statistical Laboratory in term 3.

Benefits of peer tutoring are well documented in the literature, but have been researched less in undergraduate mathematics modules that are not part of service teaching. Duah et al (2013) explore a peer assisted learning approach in a single honours mathematics programme embedded in participatory pedagogy. They were able to demonstrate a positive relationship between attendance at peer tutoring sessions and students' attainment but admit to the approach not offering a total solution to the "cooling off" phenomenon.

In this project we used fourth year undergraduate students on our integrated Master's programmes to act as peer tutors. These students have a more immediate experience of having successfully managed the transition themselves. They also have less 'social distance' from the first year students and thus are regarded as peers. We hoped that this would lead to first year students feeling more comfortable to turn to these tutors for information and advice. The peer tutors on the other hand gained a deeper understanding of the material that they taught as well as gaining experience in taking leadership roles and in communication within the discipline.

Aside from the face-to-face small group teaching delivered by the peer tutors the project also used anchored online discussion groups implemented in Moodle to deliver peer support and engage in a conversational model of learning.

Thomas (2002) and Balaji and Chakrabarti (2010) provide overviews on the literature supporting discussion forums as a tool within a conversational model of learning (Laurillard, 2013). The adoption of Laurillard's model promises to promote engagement, critical thinking, reflection and thus the achievement of higher order learning outcomes (Thomas, 2002). It may also help to establish a "community of practice" (Wenger, 1998).
Perkins and Murphy (2006) provide a model capturing evidence of critical thinking in online scripts which is adapted by Jacob and Sam (2008), who examine a discussion forum utilized in a first year mathematics module. They found that while the rate of postings increased over time, there was no marked improvement in the level of critical thinking. As suggested by Thomas (2002) the set-up of standard discussion forums can limit the extent to which interaction is able to take place and so they may fall short of realising a conversational model of learning. Guzdial and Turns (2002) discuss strategies to improve engagement and interaction for example through the use of regular discussion topics, so called anchors.

Activities

The project was delivered according to the timescales set out in the project proposals. At the start of the academic year the peer tutors were given an initial training in delivering tutorials, assessing student work and giving feedback. The training encouraged the students to adopt a student-centered pedagogy using questioning and to act as facilitators rather than engaging in up-front teaching. It thus followed the model described in Duah et al (2013) which cite Solomon (2007) as follows “mathematics can only be made accessible to all in a participatory pedagogy which encourages exploration, negotiation and ownership of knowledge”.

The six peer tutors delivered eight tutorials each in weeks 2-9 of term 1 as part of the module ST116 Mathematical Techniques. They also marked weekly work handed in by first year students. This allowed them to gain an overview of the students’ current under-standing and misconceptions and helped them prepare for the upcoming tutorial.
Dr Thonnes was available while the tutors were marking the work and provided support when needed. This support included giving an overview of current lectures, contextualizing the coursework, and explaining the role of various exercises. All peer tutors were observed once by either Dr Thonnes or Dr Crossman and were given detailed feedback as part of their observation.

The online discussion forums were provided via Moodle. For ST116 each tutorial group had their own discussion forum, but the anchors posted on each forum were the same. The initial post came from the tutorial leaders in which they introduced themselves to their tutorial group and provided a paragraph to the question “From my experience as an undergraduate student what advice would I give to first year students?” The students from each tutorial group were then invited to introduce themselves on the forum. In contrast the

ST104 forum was cohort-wide in the hopes of generating more conversation through the number of those able to participate.

After the initial introductions on the ST116 discussion forum questions for discussion were posted. Using Vygotsky's concept of the zone of proximal development (Vygotsky, 1980) the topics of discussion were chosen such that they related to material from the A-level syllabus but tied into the material delivered by ST116 Mathematical Techniques. The aim was for students to use the topics to

- expand their current knowledge and understanding;
- review concepts encountered in school and re-examine them in a more general framework;
- develop a more conceptual understanding of methods encountered previously;
- extend concepts to a more abstract level than encountered in school mathematics.

Some of the material used was developed and used with permission by the Cambridge Mathematics Education Programme (CMEP). CMEP, now re-branded as Underground Mathematics, developed resources to support and enhance A-level mathematics and enable students to "explore the connections that underpin mathematics". The material posted on the discussion forums focussed on ideas related to functions which are important concepts covered in the first year syllabus of modules in our undergraduate curriculum including mathematical analysis, linear algebra and probability.

The aim of the ST104 discussion forum was in the first instance to allow students to discuss and offer feedback on the statistical programming tasks they had been assigned, since this had been identified both in previous years and in the previous term as a particular area of difficulty.

Outcomes

The peer tutors showed great enthusiasm and engagement in delivering the tutorials. The teaching observations confirmed that the peer tutors prepared well for the tutorials and delivered effective sessions. It also showed how the peer tutors reviewed their existing knowledge of mathematics and established deeper understanding of and new connections between the covered concepts.

The feedback from first year students was also very positive. In particular, they commented very favourably on the quality of explanations they received and on the fact that some peer tutors would introduce example problems in the tutorials that linked the material from ST116 to material in other modules of the degree course.

Some negative comments were made regarding the participatory style of teaching which meant that not necessarily all of the exercises that were provided on problem sheets were discussed in class. It is not unusual to have some students prefer a more teacher- or content-centred approach, in particular as our degree courses attracts a large number of

overseas students whose secondary education is often delivered using such an approach. Duah et al (2013) report similar reactions from students.

In terms of exam results, it is not possible to attribute any effects to the peer tutoring as the module underwent various other changes.

Unfortunately the discussion forums were much less successful. Only a small number of students actively engaged with the forums despite encouragement by the module leaders and the peer tutors.

We suspect a number of reasons why the discussion forums might have been underused.

- Because the strong reliance of mathematics on symbolic notation, it is more difficult to write mathematics electronically than by hand.
- Also, the contributions to the discussion forums were purely formative and students tend to concentrate on summative work.
- In order to encourage discussion, the topics tended to be of a more open-ended nature and so students may have deduced that this material was less relevant for their learning.
- Discussion forums tend to be more popular during the revision period, but as ST116 is fully assessed in term 1 there is no extended revision period.
- On the other hand, the ST104 discussion forum was left almost entirely unused during the run-up to the exam (which took place less than a fortnight after the final lecture of the course). However many ST104 students chose to ask questions directly to Dr Crossman during his office hours, suggesting the student preference for face-to-face discussion had effectively won out over the convenience and peer-support opportunities offered by the forum.
- Most importantly, Moodle forums do not allow for anonymous contributions and the students were aware that the module leader was able to see their posts. Some students commented that they used Facebook groups instead.

The peer tutors responded to the questions raised by students on the forums and one also posted suggestions for discussion.

Hi all,

Today's Google Doodle is a rather nice one to celebrate the 200th birthday of George Boole (the 19th Century mathematician after whom Boolean Logic is named). You can find it at this link: https://g.co/doodle/bwmqtj.

Using your knowledge of truth tables from ST116 (and possibly Sets and Numbers), you should be able to predict what will happen to each of the letters in the word "Goo le" given the conditions applied to each letter and the state of the x and y where the "g" normally is in "Google".

Note that in the Doodle, the logical operator "XOR" is used, this may not have been covered in your lectures, and it means "exclusive or". The symbol that is often used to denote this is $\oplus$ and when translated into English, with two logical statements $P(x)$ and $Q(X)$, we get $P(x) \oplus Q(X)$ is equivalent to either $P(x)$ or $Q(x)$ but NOT both.

Can anybody write out the truth table for $P(x) \oplus Q(X)$? Can anybody write $P(x) \oplus Q(X)$ in terms of other logical operators that were discussed in class: "OR" ($\vee$), "AND" ($\wedge$), "NOT" ($\neg$) & "equivalently" ($\leftrightarrow$)?

The peer tutor reported that while he did not receive any responds to his post on the discussion forum students were very happy to engage in discussion about the post in the face-to-face tutorial!

Implications

The peer tutor scheme ran very smoothly and the first year students gave positive feedback on being taught by a peer. As such our department is going to continue using peers for first year tutorials provided enough suitable fourth year students are willing to participate.

As the uptake of the anchored discussion forum in Moodle was disappointing we do not envisage continuing with these in the same format. It would be interesting however to explore a forum in which submission can be made anonymously and student answered could be up-voted using likes. This would provide students with an opportunity to interact with the forum even when they are not actively posting messages.

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