Enhancing the student experience in mathematics through the use of a group project

S. R. Worsley[1] K. E. Hibberd[2] B. M. Maenhaut[3]

(Received 6 August 2007; revised 19 November 2007)

Abstract

Many Engineering and Science students enrol in first year mathematics as a requirement of their degree but feel that the mathematics is irrelevant to their chosen field. These students may also suffer feelings of isolation due to large class sizes. To address these issues a group project was introduced into a first year mathematics class with an annual enrolment of over 600 students. In groups of three or four, students explored a relevant mathematical topic of their choice, produced a poster and gave a short oral presentation. The benefits of the project include an appreciation of the interdisciplinary nature of mathematics, the development of communication, management, team work and research skills, and an increase in the students' interest in

See http://anziamj.austms.org.au/ojs/index.php/ANZIAMJ/article/view/371 for this article, Published November 30, 2007. ISSN 1446-8735

mathematics. This paper outlines how the group project idea was developed and implemented and how the students were assessed. The results of two questionnaires are presented: one completed by the students immediately after they completed the project and the other completed by the tutors who supervised the oral presentations.

Contents

1 Introduction

In the last ten years there has been a shift in mathematics education in secondary schools and universities in Australia. The number of secondary school students opting for the lowest level of mathematics has increased whereas

those taking the highest level of mathematics has decreased [1]. Thus, many students entering university are required to complete mathematics prerequisites as bridging courses in their first year. This has caused an increase in the number of students enrolled in first year mathematics bridging courses. These students bring with them a diverse range of mathematical skills and many have a less than positive attitude towards mathematics.

Some of the challenges faced by the lecturers of these large first year mathematics courses are to reverse the negative attitudes to mathematics and to help students to see the relevance of mathematics to their chosen degree. Studies of the first year learning experience have shown that the students' engagement with learning can be enhanced by a sense of belonging in groups [5]. Many of the benefits of group work are discussed in the Collier review [2] and these include an increase in students' satisfaction with the course, a desire to continue studying the subject and improved team work skills. However, introducing group work into a large mathematics class poses many challenges such as organising the large number of students into small groups, ensuring that each student understands the requirements of the group work, coordinating tutors to help implement the group work and designing appropriate means of assessing the group work. Furthermore, since the students in large first year mathematics classes have such diverse backgrounds and interests, it is important to provide topics that illustrate the relevance of mathematics to other fields.

At the University of Queensland, a mathematical foundations course has been offered for many years, and the number of students enrolled in this course has increased substantially in recent years, from 324 in the first semester of 2005 to 503 in the first semester of 2007. This course is equivalent to Mathematics C, the highest level of mathematics offered in Queensland secondary schools. The mathematical foundations course or a sound achievement in Mathematics C is an entry requirement for all engineering students. Although the majority of students in the mathematical foundations course are studying engineering, there are also many students studying science, in-

formation technology and business. In order to demonstrate the relevance of mathematics to these diverse fields and to address the feeling of isolation faced by many students in a large first year class, group work was introduced into the course. In groups of three or four, students explored a mathematical topic of their choice, produced a poster and gave a short oral presentation. In this paper the implementation of the group project is discussed in terms of organisation, topic choices, the assessment process, and the role of the tutor. Feedback from students and tutors on the usefulness of the group project is also presented. Complete details for the implementation and running of the group poster project are available online from [6].

2 Implementation

2.1 Organisation

Much of the structure of the project was established by seeking advice from mathematics staff who have run group projects in other courses. Also the Teaching and Education Development Institute at the University of Queensland supplied a wealth of information from other faculties as well as publications on the benefits of group assessment and learning [3, 4].

The group project started in the second week of lectures and took four weeks to complete. We decided that the project should be early in the semester so that the project would not interfere with the more complex mathematical concepts and greater workload that students experience as the semester progresses. We also felt that forming groups early would encourage interaction among classmates, prevent feelings of isolation and build student confidence in the course. The students formed groups within their tutorial classes and each group had three or four members. In a few cases, the tutor or coordinator assisted in group formation. Having all the group members in the same tutorial class enabled each student to have regular contact with

the other group members and also allowed for the oral presentations to be held during tutorial time.

Once formed, each group either chose a project topic from the topic list or invented their own topic with the approval of the course coordinator. Students had to inform their tutor of their group members and project topic by the second week of the project. They then had to research their topic and produce a poster. Minimising the cost of the poster production was important, so the students were to use a large card of maximum size A0, with information printed or handwritten on paper and glued to the card. The poster had to be displayed during an oral presentation of two to three minutes in the tutorial of the third week of the project. Students needed to complete five tasks in order to pass the project (see assessment details below) and, in order to facilitate the marking process, the project was worth 10% of the final mark on a pass or fail basis.

2.2 Topic choices

To incorporate a diverse range of topics from different disciplines, meetings were set up with lecturers from other disciplines such as engineering, chemistry and business. Many topic ideas came from these disciplines enabling each student either to choose a topic from their own field of study or to experience a new field and interest. As the class size is large, each group needed to be able to undertake their research with minimal individual guidance on the direction and scope of the project, so each project topic was heavily structured with specific questions to be addressed. Each topic was carefully checked so that any research information required could be obtained from the references provided. A list of twelve topics was produced including topics from mathematics, biology, chemistry and engineering. Examples of three of the topics are given below.

Nuclear Energy Waste Students were asked to investigate the energy con-

sumption of South East Queensland for an average day in winter and in summer. From these figures they had to calculate the amount and type of waste produced if that energy was provided by a nuclear power station.

Tsunami The first part of the question asked students to research how tsunamis are formed and how they change as they head towards land. The second part was to investigate existing warning systems.

Dynamic Response of Structures This project looked at the Tacoma Narrows Bridge collapse and asked students to investigate why the bridge collapsed.

Due to the level of detail provided for each project topic, only twelve topics were produced in time for the introduction of the project. Both students and tutors responded positively to the range and types of topics, especially those that involved real world applications. Popular topics included the Tsunami project outlined above, a simple example of Mendelian Genetics and a bibliography of three famous mathematicians. However, all twelve project topics were taken up and more topics will be developed.

2.3 Assessment process

As the tutors had limited time for marking it was decided that the assessment would be on a pass (and receive 10%) or fail (and receive 0%) basis. The students had to complete five tasks of which the first three were as part of a group and the last two as individuals. Each task had to be completed and passed in order to received the 10% allocated to the project. Assessment criteria were provided with detailed guidelines of what constituted a pass or a fail for each task. The five tasks are outlined below.

Progression sheet The progression sheet was introduced as the first task to encourage students to start the project early. Each group had to

complete a one page form indicating that a group had been formed, a topic chosen, tasks allocated to each member, and the first group meeting held. The form had to be completed and checked by the tutor in the second week of the project.

Production and presentation of the poster The main task was the production of a poster and the accompanying two to three minute oral presentation. The students were given clear instructions on what the poster should contain and how it should look. These instructions were given in written form and also orally during a lecture. Each group was required to give a two to three minute presentation in the third week of the project. During the presentation they were required to display their poster and give results of their research.

Peer assessment Each group was required to peer assess one other group in their tutorial class during the poster presentation. The groups were required to complete a one page peer assessment form giving comments on content, appearance, grammar and referencing.

Individual summary Each student was required to gather information about the research carried out by the other members of their group and then to summarise the results of their group project in their own words. This had to be done in 200 to 300 words and then uploaded to Blackboard (an e-Learning tool) in the fourth week of the project. The content of the individual summaries was checked for copying using the web plagarism detection software Turnitin. The originality report produced by Turnitin was checked by the tutors.

Questionnaire The final task was the completion of a questionnaire on the value, organisation and assessment process of the group project. The questionnaire consisted of 19 multiple choice questions and also provided an opportunity for any additional comments.

2.4 The role of the tutor

With such a large class size, the tutors running the tutorial classes were crucial to the success of the group project. Each tutor was required to ensure that all students within their tutorial were in a group. They also had to organise the oral presentations, arrange the peer assessment, mark the five assessment tasks, and answer general questions. Normal course work continued over the four weeks of the group project, so students still had regular tutorial problems to work on during the tutorials. In order to accommodate the group project five minutes were set aside at the end of each tutorial class for questions relating to the group project. To assist the tutors in their role clear written instructions were produced, weekly tutor meetings set up and additional help was given by the supertutor assigned to the course. The supertutor's additional role was to participate in the tutor meetings, support tutors at tutorials, answer any questions on the project topics and assist the lecturer with the running of the project. A questionnaire was given to the tutors at the end of the group project to evaluate the extra work created, assess the marking and receive tutor feedback.

3 Outcomes

Our assessment of the outcomes of the project comes from our observations and the feedback received from both the tutors and students.

Most students were in groups within the second week of the project, either forming their own group or allocated to a group by their tutor. Those that had not attended tutorials were reminded of the group project in lectures and on Blackboard. Once formed, the groups were expected to complete the work in their own time. Very few questions were raised about the topics either in the tutorial classes or by email. Several students commented that they would have liked more topics to choose from.

The poster presentations went well with groups confidently standing in front of the class presenting their work while one or two of the group members spoke. The students presenting responded well to questions from the audience. Mathematics staff and others who had been involved in the development of the group project were invited to the presentations to enable students to give their presentations to a wider audience. There was great enthusiasm from the students when presenting their results with many groups wanting more than the allocated time. The peer assessment had to be carefully organised by the tutor to coincide with the presentations. After each presentation the poster was given to the assessing group allowing for closer inspection.

Within each tutorial a winning poster was chosen, either by the tutor or by a class vote. The winning posters were initially displayed in the mathematics staff room and this created much interest in developing group projects in other courses. The winning posters were then moved and displayed outside the tutorial rooms. A prize was given to the best three posters as voted for by mathematics staff.

The students found the individual summary the most difficult part of the assessment. Many did not understand the nature of a summary or that the summary must be their own work, a difficulty to be addressed in future years. Of the 503 students who attempted the poster project 460 passed. Most of the failures were due to an inadequate individual summary submission.

4 Questionnaire results

4.1 The student questionnaire

The final assessment task was a questionnaire for the students on their experience of the group project, enabling the group project to be evaluated.

There were a variety of questions relating to the type of assessment used, the range of topics offered, the perceived support given and the information provided. There was also one open question giving students the opportunity to offer feedback. Results indicate that the majority of students increased their understanding of how mathematics relates to other disciplines and learned to work in a group. Most of the students considered the group assessment fair and felt that teaching staff gave adequate support. Over half of the students developed more interest in the group project than they expected. In the additional comments, many students indicated that they benefited from the group project from both a social and interest aspect. Some students suggested that more topics should be added and a few recommended that more higher level mathematics topics should be included. Table 1 summarises the student responses to some of the multiple choice questions.

4.2 The tutor questionnaire

After the completion of the project the tutors were asked to complete a questionnaire on their experience of managing the project, and their views on how it went. Ten out of the twelve tutors completed the questionnaire. The majority of tutors found the marking straightforward with the exception of the individual summary which they found more complex. Most tutors had no problem with the organisation of the group project and found the instructions clear. Six out of the ten tutors said that the students did not understand the instructions for the individual summary and some suggested that examples of individual summaries be provided in future. When asked about the pass/fail grade for the project worth 10% all of the tutors were of the opinion that the individual summary should be marked separately to the other assessment tasks in the project. Table 2 summarises the tutor responses to some of the multiple choice questions.

TABLE 1: Student questionnaire summary as a percentage of those submitted

Question	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I developed more interest in the topic that I expected	10	43	31	12	4
I have increased understanding of how mathematics relates to other disciplines	10	58	22	7	3
I am inspired to continue my studies in the field	6	27	47	15	5
I have learned to interact effectively with group members	20	61	15	3	1
Working in a group was an effective learning experience	14	50	24	8	4
I have learned how to prepare materials for presentation to others	6	45	38	9	2
I have developed skills in research and problem solving	3	35	42	16	4
I have learned skills that I would not have learned from lectures and tutorials only	8	38	32	17	5
Teaching staff provided enough guidance and support	13	49	26	9	3
I received adequate feedback on my contribution to the group project	4	45	40	10	1
The group assessment was fair	7	67	21	4	1

TABLE 2: Tutor questionnaire summary as a percentage of those submitted

Question	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
It was difficult to organise students into groups	0	10	0	60	30
The poster project caused many organisational problems for the students	0	0	30	60	10
It was difficult to organise the peer assessment in my tutorial groups	0	0	10	40	50
Students continue to work in groups in the tutorials	10	60	10	20	0
I understood what was required of the students with regard to the individual summary	60	30	10	0	0
I found it easy to assess the originality reports using "Turnitin"	0	60	0	40	0
Instructions for running the poster presentations in my tutorial group were clear	30	50	10	10	0
I had difficulty answering student questions on the topics given	0	10	30	40	20

5 Discussion and conclusions

The aims of introducing a group project into the mathematical foundations course were to promote an interest in mathematics by demonstrating the relevance of mathematics to other disciplines, to develop teamwork, research and presentation skills, and to address the feeling of isolation that some students experience in a large class. The outcomes of the project and the responses on the student questionnaire show that these objectives were achieved.

The challenges of introducing group work into a large class setting were met by focusing on the tutorial classes and by providing clear instructions to students and tutors. Groups were formed within the tutorial classes and the tutors were given an active role in implementing and assessing the group work. Each project topic was carefully structured with specific questions to be answered so that students needed minimal guidance. The five assessment tasks ensured that students started the project early and knew exactly what had to be done. The assessment was designed in such a way that it was efficient for tutors to mark.

The group project was introduced successfully in the first semester of 2007 and it will be included in the course in future semesters. Based on our experience the following improvements will be made:

- More detailed explanation of the individual summary will be given including examples of precisely what is expected.
- The assessment will be adjusted so that 4% is allocated to the individual summary on a pass/fail basis and 6% is allocated to the remaining four assessment tasks (also on a pass/fail basis).
- More topics will be developed increasing the choice for students.
- An additional supertutor will be assigned for the duration of the project.

Overall the group project was a very positive experience for students, tutors and staff.

References

[1] Barrington, F. Participation in year 12 mathematics across Australia 1995–2004, ICE-EM, 2006. http://www.ice-em.org.au/pdfs/participation_in_yr12_MathsFinal.pdf C202

[2] Collier, K. G. Peer-Group Learning in Higher Education: the development of higher order skills. *Studies in Higher Education*, 5, 55–62, 1980. C202

[3] Isaacs, G. *Assessing group tasks*. Teaching and Educational Development Institute, The University of Queensland, Brisbane, Queensland, 2002. C203

[4] Kazlauskas, A., Gimel, S., Thornton, L., Thomas, T. and Davis, T. *Embedding group work in the first year experience*, First Year in Higher Education Conference, 2007. http://www.fyhe.qut.edu.au/past_papers/papers07/final_papers/pdfs/1d.pdf C203

[5] Krause, K-L., Hartley, R., James, R. and McInnis, C. *The First Year Experience in Australian Universities: Findings from a decade of national studies*, Canberra: DEST, 2005. C202

[6] The Mathematics Education web page at The University of Queensland https://www.maths.uq.edu.au/mathsed. C203

Author addresses

1. **S. R. Worsley**, Department of Mathematics, University of Queensland, Brisbane, AUSTRALIA.
mailto:srw@maths.uq.edu.au

2. **K. E. Hibberd**, Department of Mathematics, University of Queensland, Brisbane, AUSTRALIA.

3. **B. M. Maenhaut**, Department of Mathematics, University of Queensland, Brisbane, AUSTRALIA.