<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>The use of collaborative learning in the teaching of operational research to mathematics undergraduates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author(s)</strong></td>
<td>K. C. Tan and A. Y. Chen</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>Excellence in Science Teaching at Tertiary level: Proceedings of Teaching in Science Seminar (pp. 81-85). Singapore: National University of Singapore, Faculty of Science</td>
</tr>
<tr>
<td><strong>Publisher</strong></td>
<td>National University of Singapore, Faculty of Science</td>
</tr>
</tbody>
</table>

Copyright © 1993 National University of Singapore, Faculty of Science

This document may be used for private study or research purpose only. This document or any part of it may not be duplicated and/or distributed without permission of the copyright owner.

The Singapore Copyright Act applies to the use of this document.


This document was archived with permission from the copyright holder.
The Use of Collaborative Learning in the Teaching of Operational Research to Mathematics Undergraduates

Tan Kok Choon  
Department of Mathematics  
National University of Singapore

Chen Ai Yen  
School of Education  
National Institute of Education

1. Introduction

It is generally recognised that tertiary education should help students develop their critical thinking, communication and interpersonal skills. These skills have been identified to be essential for success in their careers and lives. However, there have been criticisms that these skills are not well-developed in many of our undergraduates, partly because of their passive learning styles and partly due to lack of opportunities for them to interact and socialise among themselves and with members of the teaching staff, both inside and outside of the classroom.

Many of our undergraduates would admit that their immediate concern is to pass the examination rather than to consider whether the knowledge they acquire will be meaningful or useful in their lives. Faced with a tight lecture schedule and a heavy load of tutorial and laboratory assignments, students often resort to "rote" learning by memorising as much information as possible from lectures and tutorials. This leads to a general absence of deep learning and appreciation of the subjects they study in the university.

It was felt that the current practice of tutorial classes in the Mathematics Department at NUS, which are mainly problem-solving sessions, could do more to promote active learning and encourage student participation and interaction. This paper reports on the use of a collaborative learning strategy to encourage active student participation and to facilitate deep and meaningful learning of Operational Research, an optional applied mathematics course in the third year Mathematics A and Computational Science curricula. Actual experience of the use of this strategy by the first author will be discussed.

2. Collaborative Learning

There are various labels in use for collaborative learning. The most common among these labels include co-operative learning, collective learning, learning groups, and learning teams. What is collaborative learning? The steering committee of the American Association of Higher Education's Action Community on Collaborative Learning stated:

"Collaborative learning in undergraduate education is a pedagogical style that emphasizes co-operative efforts among students ... it benefits participants by making them more active as learners and more interactive as teachers."

[Whipple (1987), p. 3]
In other words, collaborative learning moves students from the passive form of learning to an active form. Concomitantly, the most effective collaborative learning strategies are predicated on the notion that having students work together is a powerful method for inducing learning and that every student is responsible for his or her own learning as well as that of his or her other group members. Thus, the use of collaborative learning moves away from the negative and often devastating effects of competition and aims at increasing the number of "winners" in a class by bringing about success for the greatest number possible. Equally significant is that these strategies focus on both the cognitive and affective concerns of higher education. Such strategies aim at increasing the academic achievement as well as the co-operative or social skills and interaction of students. Also, "there is wide agreement among reviewers of the collaborative learning literature that co-operative methods can and usually do have a positive effect on student achievement." [Slavin (1989/1990), p. 52]

Collaborative learning is not a recent innovation. For example, Miel (1952) emphasised co-operative tasks in classrooms. Over the years, teachers (from primary through graduate school) have used collaborative learning-like methods such as group projects, laboratory partners, and research teams. The first author had personally experienced the positive effect of collaborative learning as an undergraduate here through an Honours course in Topology taught by Associate Professor A. J. Berrick in 1983/1984. However, it should be pointed out that that was a small class of five highly motivated Honours students. Reported in this paper is an attempt to introduce collaborative learning to a larger class of heterogeneous students with diverse levels of motivation and ability.

A multitude of collaborative learning strategies has been developed, field tested and researched. [See Toteet el al (1991).] Johnson & Johnson (1979) had argued that "Science, with its emphasis on experimenting and critical thinking, is an excellent place to start cooperative interaction and teach the skills which will make students more effective in working with each other." Also, Professor Segio Piccinin, in a keynote address at the Seminar on Teaching in Science at Tertiary Level held here in 1991, gave a list of "Seven Principles of Effective Teaching" [Fenwick & Piccinin (1991)]. The second principle in his list is: "Develop reciprocity and cooperation among students. Effective learning is collaborative and social, not competitive and isolated."

In the following section, we describe a collaborative learning strategy which the first author had used in his Operational Research class. (Operational Research is an optional course in the third year Mathematics A and Computational Science curricula.) After implementing the strategy, the authors discovered that it is in fact very similar to the Student-Teams Achievement Divisions (STAD) strategy developed by R. E. Slavin. [See, for example, Slavin (1986)].

3. A Case Study On Collaborative Learning

The purpose of this study is to assess the use of a collaborative learning strategy to promote active learning and encourage student participation and interaction in the teaching of Operational Research to mathematics undergraduates. The students involved were third-year undergraduates in the Faculty of Science at NUS majoring in Mathematics or Computational Science (with specialisation in Computational Mathematics). They are studying Operational Research as one of the three optional courses that they are required to read for Computational Science or Mathematics A. This strategy was implemented in all the tutorials classes that were assigned to the first author this academic year.

In the current usual practice in the Mathematics Department at NUS, students attend two one-hour lectures and an one-hour tutorial class each week for the course. During lectures, the lecturer provides the basic definitions of terms, explains the concepts and illustrates or demonstrates the basic schema for solving problems covered by the course. These definitions, concepts and schema need to be understood, assimilated and then applied. Tutorial classes are meant to help students to clarify their understanding of the material covered in lectures and then to see how the schema may be applied.

During tutorial classes, it is common for students or the tutor to present, to the rest of the group, their solutions of problems pre-assigned by the lecturer teaching the course. There is often very little discussion among students on the solutions presented. Questions or clarifications, which are very rare, are usually directed towards the tutor as though his or her answers are to be taken as the definitively correct ones and that they should be accepted without any question or challenge.

This practice results in the tutor taking a dominant role in tutorial classes (for most of the fifty minutes of the tutorial class, he is talking and explaining, or commenting on solutions provided by students) and the level of student participation and interaction tends to be low (most of the students would be busily preoccupied with the transcription of the solutions given and the tutor's comments onto their notebooks so that they may "rote learn" these for examination). Thus, learning is in a very passive form and there is little encouragement for the students to interact or socialise among themselves. As a consequence, there have been observations that some of our students are poor in their critical thinking, communication and interpersonal skills, and there is a general absence of deep learning and appreciation of the subject. Student achievement also tends to be low.

The collaborative learning strategy used by the first author in his tutorial classes and briefly described below is very similar to the Student-Teams Achievement Division (STAD) strategy [see Slavin (1986)]. STAD begins with the presentation of material by the teacher. Students then work in heterogeneous teams to master the material.

During the first meeting of tutorial classes at the beginning of this academic year, the students were asked to form groups of three or four members, and they were given the choice to pick their own group members. Eventually, a few groups of two or five members were also formed. They were then told to work through and discuss all the tutorial problems before the class meets in subsequent meetings. Five or six tutorial problems are usually assigned for each week. These are more than what an average student, working alone, can handle. Therefore, the only way that all the problems can be covered is for the students to work effectively in groups.

During subsequent meetings of tutorial classes, the tutor would appoint some students to raise for discussion questions on tutorial problems that their groups have found particularly difficult. The tutor then uses questions to prompt or guide the students to get the solution to the problem. He may also redirect the questions raised to the other groups. Despite students' persistent requests for "model answers" at the end of each tutorial class, the tutor would not provide any solution to them. This is done to make each student be responsible for his or her own learning as well as that of his or her other group members and because the best way to learn how to solve problems and the subject is to solve the problems, not to study the solutions.

4. Preliminary Assessment

At the time of writing of this paper, the strategy had been implemented for only five weeks. However, there are already some apparent positive results. First, there are observable qualitative improvements in terms of the enhanced levels of student participation and interaction, at least within if not among the groups, although there are a small number of groups which do not seem to be working well together. (Members in these groups tend not to talk much or participate in discussion and they may even sit far away from each other.) Also, most students had shown a greater enthusiasm for
learning and had informally expressed a keen interest in this new approach. As one student said, "It is quite stimulating." Another student, who is repeating this year and had taken the same course in the previous year, said:

"It is better than last year because we can get a better understanding of the basic concepts and theory underlying the methods and computations."

Secondly, as can be seen in the following, the indication is that the academic achievement of students is expected to be high. In the fifth week of tutorial, a quiz was given to all the students taking the course. The quiz question, which was based on the material that has just been covered in lectures, was taken from the examination of the previous year. The quiz scores (the maximum score is 14) of the various tutorial classes are summarised in the following table.

<table>
<thead>
<tr>
<th></th>
<th>Monday</th>
<th>Wednesday</th>
<th>Combined</th>
<th>Last Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Students</td>
<td>28</td>
<td>30</td>
<td>58</td>
<td>107</td>
</tr>
<tr>
<td>Average Score</td>
<td>10.2</td>
<td>8.1</td>
<td>9.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.2</td>
<td>3.5</td>
<td>3.1</td>
<td>3.4</td>
</tr>
</tbody>
</table>

It should be pointed out that this is only the result of one quiz. Therefore it may not be statistically significant. However, if we can assume that the students of this year are not much different from those of the last year, then this new approach seems to have induced a significant improvement in the level of student achievement, taking into consideration the fact that it was the same lecturer who taught the course last year and he had not changed much in his presentation of the lecture material.

5. Conclusion

The present study has demonstrated the effectiveness of a collaborative learning strategy, in the teaching of the course Operational Research to third year mathematics and computational science undergraduates, to improve student achievement, induce greater enthusiasm for learning, as well as encourage student participation and interaction in class. However, the improvements seen are only in a general sense; there are a small number of students who do not seem to benefit from this strategy. This observation raises some interesting questions for further research. For example, "Why didn’t the strategy seem to work for everyone?"

"Who are those that will or will not benefit from this strategy?"

In other words, "what types of students will benefit most from collaborative learning?"

To answer this question, we will need to conduct further analysis of the student types and the students’ learning styles in terms of their abilities, personalities and other human factors, like personal relationships and "kiasuism".

Another question is: "Can collaborative learning be useful and effective in teaching other mathematics courses, subjects in the other departments of the Science Faculty, or other faculties?" The answer is most likely to be in the affirmative. Experience and research conducted overseas have indicated that collaborative learning is effective in promoting active and deep learning and increasing student achievement as well as communication and interpersonal skills, at all levels and in all subject areas [see Bouton & Garth (1983) and references in Totten et al (1991)].

References


References