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Interteaching in a second year chemical engineering undergraduate project-based course

Raj Parthasarathy [a] and Margaret Jollands.
RMIT University, School of Civil, Environmental and Chemical Engineering
[a]*Corresponding Author Email:* rchrp@rmit.edu.au

BACKGROUND

This paper reports on improvement in students' learning and satisfaction in a 2nd year chemical engineering project-based course following the introduction of 'interteaching' model. In traditional lecture and tutorial based learning, students have no mechanism to give immediate feedback about their learning of fundamental concepts and their application in problem-solving. They also have no resources other than text books and lecture notes to help them in addressing these issues after lectures or tutorials. The interteaching approach requires the students to come prepared to the tutorials and solve problems as a group attempt. Students complete an interteaching survey at the end of each tutorial using which the lecturer prepares a number of podules and make them available in distributed learning system. The podules reinforce some of the difficult concepts and demonstrate problem-solving. Students have access to the podules until the end of the semester.

PURPOSE

This study focused on the question, can interteaching enhance student learning and satisfaction in a core engineering course such as mass and energy balance?

DESIGN/METHOD

Students work as a group in interteaching sessions to solve problems. Tutors and the lecturer interact with student groups and help them in their problem-solving exercise. Students get marks for attending the tutorials and completing the interteaching surveys. Students' learning in the course was measured using their performance in the end-of-semester test. Their learning experience and overall satisfaction in the course was measured using the feedback in staff-student consultative committee (SSCC) meetings and good teaching scale (GTS) in course experience survey (CES).

RESULTS

Fifty six per cent of students attended all interteaching tutorials. Pass rate in the final test for the course has increased to 85% in 2012 compared to 80% in 2010. Feedback in SSCC meetings on interteaching tutorials was positive. GTS score from CES has increased significantly to 74% in 2012 compared to 50% in 2011 and 2010.

CONCLUSIONS

Interteaching model is an effective approach which allows students to take control of their learning. This approach encourages students to take responsibility for their independent learning. In this model, students spend less time on listening to the lecturer and more time in interactive group work and problem-solving.

KEYWORDS

interteaching, student engagement, project-based learning, podules.

Introduction

Interteaching was developed by Boyce and Hineline (2002) as an alternative to traditional lecture-based teaching methods. This model is based on a view that "learning is something a person does, not something that happens to him or her". Learning is evidenced by a change in behaviour – after learning, students can do things that they couldn't do before. Interteaching incorporates guided independent learning, student-paced small group tutorial discussions or reciprocal peer tutoring, and brief lectures developed in response to student feedback. A distinctive feature of this model is that tutorials precede lectures that have been developed on topics in which students need more direction. Students are expected to come prepared for tutorial classes, where they form small groups and discuss the topic material and try to find answers for questions posed by the lecturer. Students are expected to know the answers before they come to the tutorials and be able to explain them to their peers. At the end of the each tutorial, students complete an 'interteaching record' which is a survey that asks students to report on the most challenging and interesting aspects of the topic and tutorial questions. This student feedback is analysed by the lecturer who then develops online lecture materials on topic that are in need by the students and make them available as online Podcost modules.

Interteaching attempts to overcome some of the limitations of other similar models such as co-operative or problem-based learning (Saville et al, 2006). Lectures, if any, are brief, on-line and focused on what the students have requested; students are given weekly pre-class guides with questions designed to prepare them for the next tutorial class; tutorials are focused on small group discussion of questions prepared for the class, and students are given marks for their contribution to their group.

Interteaching model has been implemented in a number of Universities in the United States especially in psychology programs and students in the programs have shown preference to interteaching model over traditional teaching model (Saville et al., 2005, 2006). This model has also been used in mathematics and science programs in Griffith University (Gregory, Clarke & Bridgestock, 2009). The authors reported that there was anecdotal evidence that this was "well received by students". This model was also used in RMIT University in the 2nd year 'Development Psychology' course taught in 2010 (Kienhuis et al 2010, Kienhuis 2012). It was found that this approach led to many positive outcomes. Students reported increased satisfaction, especially in later year courses.

It is clear from the discussions above that the interteaching model appeals to students. It gives them control over what and when they learn. It encourages them to take responsibility for their own learning. To date it has been applied to a limited range of student courses. However it is possible that the positive impacts of interteaching could benefit students of any program or discipline. The original work by Boyce and Hineline (2002) was not discipline specific; rather it was based on fundamental principles of human behaviour that would apply in any learning situation. It is of interest to see if an enhanced teaching approach can benefit engineering students. Engineering undergraduates are expected to learn multiple new concepts and apply them to design and solve problems. One of the courses taught by the authors is a 2nd year course for chemical engineers on mass and energy balances. Before 2012, the course was taught with a traditional lecture and tutorial approach. Lectures covered presentation of new materials and solutions of short problems on a white board. Tutorials covered more complex problems; students tackled these problems on their own with the help of tutors and peers. Students did no preparation for lectures or tutorials. There was no mechanism to report

any learning problems and conceptual misunderstanding to lecturers or tutors. Students did not have any resources to use after class, except for a text book. A significant percentage of students (up to 30%) would fail the course test, and as this was a hurdle, failed the course overall.

In 2012, the interteaching model was introduced to this course.
. The activities and outcomes are described in the following sections.

Research Question

This study focused on the question, can interteaching enhance student learning and satisfaction in a core engineering course such as mass and energy balance?

Design/Method

The effectiveness of interteaching was evaluated using students' attendance in interteaching tutorials, student feedback in SSCC meetings, students' grades in mass and energy balance test, and end-of-semester CES results.

Student's attendance in interteaching tutorials was used as one of the parameters to measure the effectiveness of interteaching. Interteaching tutorials were conducted once a week. Each tutorial was 2 hours in duration. The first 30 minutes of the tutorial session was used by the lecturer to introduce the tutorial topic for the week and demonstrate problem-solving using one or two worked-examples. This mini-lecture was recorded on Lectopia and made available as Podcost on the RMIT University distributed learning system. The following 1.5 hours was used for a face-to-face problem solving tutorial. Students were asked to solve 2 or 3 problems on mass and energy balances in groups. 3 tutors and the lecturer were available to help them in solving problems. Towards the end of the tutorial session, students were asked to complete a survey which asked them to indicate the topics or concepts on which they have difficulties in understanding and applying in problem solving. Completion of this survey helped the students to gain 1 mark per week. There were 9 interteaching tutorials in the semester. Students who attended all 9 tutorials were given an additional 1 mark as a bonus.

Feedback in Student-Staff consultative committee (SSCC) meetings was used to gauge the students' learning experience and satisfaction in interteaching tutorials. SSCC meetings are held twice a semester in weeks 5 and 11 of our 12 week semester. Prior to the meetings, student representatives visit classrooms and gather feedback from students and prepare a list of issues. These issues are discussed in detail at the meeting which is attended by student representatives from all year levels and the program director. These meetings are facilitated by the program director but are run essentially by the students. Minutes of the meetings are written by a student representative and distributed to all teaching staff. The first SSCC meeting usually gives early warning on some of the aspects that are not working well in the program and provides opportunities to teaching staff in addressing them sooner.

An end-of–the semester test is used to evaluate student's learning and competency in solving problems on mass and energy balances. This test is the only individual assessment in this project–based course. Other assessments such as progress and final reports, and oral presentations are group assessments. The final test is also a hurdle and students are required to get at least 40% in this test to pass the course. We consider an improvement in students' grades in this test to be a good indicator of the effectiveness of interteaching tutorial (problem-solving) sessions and podcasts available on the distributed learning system.

The end-of-semester course experience survey (CES) is another tool that provides useful data on student's experience in the program. This survey is conducted online and it can be used to obtain students' evaluations on different aspects of the course. For example, students were asked to evaluate the project and interteaching parts of the course separately. The University's Survey Centre analyses the survey results and reports scores on good teaching and overall satisfaction in the course.

Results

Interteaching tutorials were introduced into this 2nd year course only in 2012. As mentioned earlier in this paper, the course was taught with a traditional lecture and tutorial approach and it was not compulsory to attend either the lecture or tutorials. In 2012, about 56% of the class attended all interteaching tutorials and received full marks for the attendance. About 15% of the class attended 8 out of 9 tutorials and remainder of the class attended less than 8 tutorials. The staff observed that the attendance in tutorials was higher than in previous years. However, there is no data available on tutorial attendance from previous years Therefore, the link between tutorial attendance and improving students' learning and satisfaction is only a tentative conclusion at this stage.

In 2012, students were encouraged to attend the interteaching tutorials with a variety of incentives: they were encouraged to work in groups to solve problems and marks were given for completing the weekly interteaching survey. We noted that a small fraction of students skipped the first half of the tutorial and attended only the second half solely for the purpose of obtaining marks for attendance.

Feedback obtained on interteaching tutorials was positive in mid-semester and end-of-semester SSCC meetings. Students reported that the lecture notes and quiz made available in the distributed learning system helped them well in preparing for the interteaching tutorial sessions. In addition, podules that demonstrate solving mass and energy balance problems were reported to be very handy especially when they were preparing for the final test. It was pointed out that these podules are helpful in reminding them about integrating and applying the fundamental concepts in problem-solving. It was a particularly pleasing outcome that the students suggested that the interteaching approach should be adopted in other chemical engineering courses that involve problem solving.

The end-of-semester test on mass and energy balance, as mentioned above, is a hurdle and students are required to obtain 40% and above to pass this course. In previous years, many students who could do well in the group work in the course struggled to pass the test. Failure rate could be up to 30% in previous years. In 2012, about 15% of students failed to pass this test and consequently failed the course. Failure rate in 2010 in this course was 20%. However, it is interesting to note that the average mark for the test remained more or less constant at about 65% in both years. Based on these figures, it can be concluded that interteaching tutorials and podules on problem-solving assisted students' understanding of mass and energy balance concepts and helped them to apply the concepts in problem solving.

Interteaching tutorials and the availability of podules led to a significant increase in student satisfaction in their course experience. The CES conducted by the University reports two key scores namely, good teaching scale (GTS) and overall satisfaction index (OSI). Among them, GTS is considered to be a good measure of the effectiveness of students' learning. GTS score for this course in 2012 was 74% which is significantly higher than 49 and 50% obtained in 2011 and 2010, respectively. The OSI result for 2012 also increased significantly to 77% compared to 57% for both 2011 and 2010. It should be, however, noted that both GTS and OSI results mentioned above for 2012 are only for interteaching part of the course whereas

the results for 2011 and 2010 are for the whole course. We can conclude that interteaching was their favourite part of the course in 2012.

The above findings suggest that interteaching tutorials and the podules have increased the effectiveness of students' learning and satisfaction in this course. However, this conclusion is based on one trial in 2012. Effect of interteaching needs to be studied further over a period of another 2 or 3 years before making any firm conclusions.

Conclusions

Students learn effectively when they have control over what and when they learn. Interteaching model, which gives that control to the students, was introduced in RMIT University in one of their 2nd year project-based course engineering course. This is probably the first attempt to use this approach in an engineering course. In this approach, students learn the concepts independently and apply the concepts to solve problems as a group in interteaching tutorial sessions. At the end of tutorial, they complete an interteaching survey to inform the lecturer about the topics/concepts in which they need more information or help. Using students' feedback, the lecturer prepares podules of approximately 30 minutes duration on selected topics and makes them available in distributed learning system. Students' attendance in interteaching tutorials increased significantly in 2012 as compared to previous years. Number of students passing the final test in this course increased to 85% in 2012 compared to 80% in 2010. Students' feedback in student-staff consultative committee meetings on interteaching was positive. Also, good teaching scale obtained from course experience survey has increased significantly to 74% compared to 50% in 2011 and 2010. Overall the interteaching approach provided students flexibility and greater control in their learning which led to their better performance in the final test and overall satisfaction in the course.

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