

Peer Instructions to Improve Active Learning

by

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Abstract

Enhanced oil recovery studies include high mathematics, chemical reactions and advanced simulations. In order to maintain a level that is appropriate for undergraduates, a lot of descriptions and explanations are required during teaching. Thus, preventing students from falling into a passive state during lectures is a concern. This paper aims to share the method used where part of the teaching is substituted by small group discussions headed by a student. All students would be teaching a topic or some topics while learning other topics from their classmates. From class observations, the students were interacting with students who were teaching more than they would with the lecturer in a formal lecture. Other aspects of group learning were incorporated in the coursework. It was concluded that students teaching their peers in a small group environment was effective in keeping students engaged in learning activities.

Introduction

Students teaching their peers in a small group environment was a method used at another school to address the problem of students having different levels of preparedness (1). It was found to be successful in increasing the passing rate. This method is now be used to reduce inattentiveness and passivity in class at the Universiti Teknologi Petronas (UTP).

One of the advantages of teaching engineering courses is the significant amount of quantitative analyses present that engenders active learning. Students can be assigned simple tasks during the class to keep them focused. There are also courses that require high level mathematics and complex chemical reactions if quantitative analyses are part of the syllabus. Enhanced oil recovery (EOR) is an elective course for final year students in Petroleum Engineering at UTP. Much of the course is kept at a low level because the application of EOR concepts require high level mathematics, chemical behavior and simulations that will be too advanced for undergraduates. In this case, low level is associated with the outcome that the students are able to describe a certain concept. For example in miscible displacements, a low level approach is to describe condensing drive using a ternary diagram while a high level approach will mean that the student is able to use the method of characteristics to predict condensing drive. As a result, the delivery is the traditional lecture which sees the lecturer talking and

the students listening passively. While this method is effective for the first 15 or 20 minutes of the lecture for almost all students, very few seemed to be engaged for a longer period.

This paper aims to share the method used where part of the teaching is substituted by small group discussions headed by a student. Several steps are taken to maintain the standard of learning. Quizzes and assignments are also used to introduce new concepts in place of lectures. E-learning is also extensively used.

EOR Course

The course is offered in the first semester of the final year of the undergraduate petroleum engineering programme. A student who has passed a basic petroleum engineering course (such as principles of reservoir engineering course or reservoir rock and fluid properties course) is sufficiently prepared for this course. He or she is able to explain oil recovery, common rock properties and fluid properties. The processes in EOR consist of injecting a fluid or several fluids into a well which will, hopefully, push oil out into the producing well. Considering that the injected fluid can range from water or air to complex polymer, surfactants and alkalis, and crude oil has more than 100 components, then predicting the behavior and results of these displacement processes are challenging.

The course at UTP covers a whole range of EOR processes. More time is spent on water flooding since it is used in most oil production operations. The commonly used frontal displacement theory is derived and applied. Students learn to use several prediction methods. Steam flooding is also a major EOR method. Students are taught to predict oil recovery by steam flooding using equations, without deriving these equations because EOR is a low level course. Choosing a process for a particular field falls under the screening process in which various reservoir conditions and engineering limitations are considered. The students require a lot of information before they are able to choose an appropriate EOR method. Recovery mechanisms are physical phenomena that occur in the reservoir causing oil to be produced. As a very important factor in EOR, recovery mechanisms require extensive explanation and qualitative description.

In general, a lot of descriptions and explanations are required of the lecturer and thus, preventing students from falling into a passive state during lectures is a concern.

Active Learning

Many papers on engineering teaching and learning are available in literature (2). The types of learning and the implementation of each type are just as numerous (2). One of the major concerns is to get the student involved in learning rather than being taught or the well-known phrase of being 'spoon-fed'. Another concern is the need for students to work effectively in a group. Consequently, we read about cooperative learning, problem-based learning, inductive learning and numerous other learning methods which sometimes seem to be variants of one another.

In this paper, active-learning is used to refer to students learning by being taught by their peers in class as opposed to being taught by a lecturer. All students would be teaching some topic or topics while

learning other topics from their classmates. Rotation of roles in learning and teaching is different than cooperative learning as defined in literature (3). Students are being taught by a classmate in small groups of four instead of a class. In this environment, it is hoped that students are learning better since they are kept engaged during the class. Teaching also forces a student to increase his or her comprehension and skills. The main aim is to reduce the opportunity for the students to doze off or allow their mind to wander during class hours. Therefore, several activities are conducted by the students in learning EOR. Nevertheless, the final yardstick of learning is still the traditional, exams, quizzes, assignments and projects.

Learning and Teaching Activities

Unlike many engineering classes at UTP, the EOR course has only 20 students. The huge class problems that faced many lecturers are absent (4). UTP students also went through a stringent screening before being admitted, especially to the Petroleum Engineering programme. They, therefore, have similarly high academic abilities and the pace of teaching or learning can be uniform (1). The course is being offered for the first time and no comparison can be made with those of previous years. A survey of students' opinions and in-class observations are used to assess the effectiveness of the method employed.

For any topic, the lecturer started teaching by delivering the basics and also the overall arrangement of the subject matter. It allowed the students to gauge the depth and breadth that they were expected to learn. Students were divided into groups of four, which had been found to be an ideal number from the lecturer's observations over years of teaching. The contents of a particular topic were divided among the groups, depending on the complexity. A smaller subtopic was assigned if more work was required. During the lecture hour, the group that was assigned a particular subtopic would then appoint each member to teach one group. This means the number of members in each group should be at least equal to the number of groups to be taught.

In order to guide the students, several steps were taken. Several textbooks were chosen as references and students prepared their notes using those text and other necessary additional references. Notes were vetted by the lecturer before the teaching sessions. The outcomes of the topics were given. Reviewed notes, which incorporated lecturer's suggestions, were posted on the E-learning page after the class. Students were always assigned a task at least a week before their session. The teaching session usually took up about 40 minutes.

However, it should be emphasised here that about forty percent of course was taught by the lecturer.

Course work

Although a course work such as assignments, quizzes etc. is not peculiar to active learning, the assignments and a project were designed to encourage group work. In each of the four assignments, group questions were included in addition to questions that all students must attempt. The EOR field project was assigned as a class project. Sixty percent of the project marks was allocated to group work and the rest to individual contribution which was monitored using the Moodle E-learning journal option.

Class Observations

A major improvement over conventional lectures was that the students were interacting with each other during all of the teaching sessions. It was observed that not all in the group were actively participating every time. One or two students in the class seemed as passive and inattentive as in normal classes; however at the end, each one had gone through three teaching sessions, which means he or she had gone through some form of active participation. In a normal lecture delivered by the lecturer, it was unusual to have more than two or three questions per class despite promptings for questions. This could be due to the small group presentation where the students felt more comfortable questioning a classmate. There was also a possibility that the students might have had reservations about the ability of their peers. This aspect will be raised in the coming end of semester survey. A more responsive and lively reaction than normal was observed in class when the lecturer reviewed the material covered in the student sessions

Earlier in the semester, the students did not seem to have much confidence in the material taught by their peers. The lecturer was asked a few times to confirm the material presented during the first session. It was necessary for the lecturer to ask them to refer to the text books for confirmation so that the teaching student and the learning students were able to develop confidence in using references. The lecturer only intervened when some answers were not available in the recommended references. In the beginning, there were arguments on basic terms that were taught in the previous semesters. The lecturer again had to intervene by keeping them focused on the current topic and any arguments on basic information should be settled after the class. As the sessions progressed, the students were addressing their questions to the teaching student as well as holding discussions with other members.

Results of Survey

The survey in the appendix was given before the mid-semester break and one round of teaching sessions had been completed. Even though only 11 students out of 20 responded, some idea of what students thought was useful for improving the method for next semester.

The survey was designed to assist in improving the current method plus planning for future application. It was not meant to be a statistical study since the number of students was small. The opinions of the students were sought through indirect questions. For example, the students' satisfaction with the effectiveness was questioned by asking if they became more interested in the subject matter before and after the teaching sessions. They were also asked if the learning sessions (taught by other groups) assisted them in answering the mid-semester test. This approach has been found to be necessary since lecturers are usually assessed by students with questions such as 'Are the lectures clear?', 'Are the presentation well –designed?'. These ratings had never been helpful to the author in improving teaching.

The results showed that the students were generally satisfied with the way the course was conducted except for the assessment method. An important result was that all but one student found their interest in the topic had increased after the teaching as well as the learning sessions as shown by the

effectiveness score. One student was unsatisfied with the effectiveness of the course, the preparation time as well as personal benefits.

One student found his/her topic long and complex. This factor will be looked into in the next semester. The division of topics may be revised. They were satisfied with the implementation and preparation load. Seven students wanted the teaching sessions to be assessed by the lecturer, two by their peers and two by no one. This response was considered an 'unsatisfied' result. Comments in the survey indicated that more than half of the respondents wanted more involvement of the lecturer either by over-viewing the teaching sessions or explaining the outcome in greater details. Two were happy to be allowed to acquire knowledge themselves or in their words 'study like university students'.

Analysis

From observations and survey results, the peer instruction mode used was satisfactory for most students (who responded) in the EOR class. They have not experienced this form of teaching in any of their classes, either in this semester or in earlier years. It is understandable that they wanted more lecturer involvement in their teaching sessions. However, to their credit, most of them were open to this method which required more effort from them during the semester. Their mid-semester test results showed that 19 students received 66% to 100%. Some tweaking is necessary for future application. One method in consideration is to give a reading assignment before each topic as an introduction to the topic. The reference materials may be compiled into one volume so that they will know that they are presenting the sanctioned information.

For larger numbers of students, this method is still workable. For example if there are sixty students, there can be fifteen groups; each one having four students. Since the number of students from the teaching group must be equal to the number of learning groups, it is necessary to assign three groups, i.e. twelve students to teach one subtopic. The lecturer may need to be more involved in synchronising the notes before each session since now there are twelve students who need to synchronise what they teach instead of the four students in the EOR course. The lecturer may also need to teach a bigger percentage than for a small class so that all students are instructed on the same materials. Interspersing formal lectures with student teaching sessions or vice versa is a way to maintain student interests.

Conclusions

In conclusion, introducing peer instruction in class has reduced the inattentiveness and passivity among students. They had more practice to interact in groups, and so far their grades had been good. This method had worked for these students since the class was small and being from a highly select group, they were a motivated group of students. It is expected to work with bigger classes, albeit with modifications.

References

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- 3) Smith, K.A, Cooperative learning: effective teamwork for engineering classrooms, Proceedings - Frontiers in Education Conference, v 1, p 208-213, 1995
- 4) Smith K.A., Enhancing large classes with Active and cooperative learning, 10 th Annual Summer Institute on College Teaching and Learning, Michigan State University, USA, August 2005

Appendix

Summary of Results

	Questions	No. of students responded (Total students=20)		
		a)	b	c
Equitable and appropriate distribution	My group was assigned a topic that was a) more difficult or b) as difficult or c) less difficult than others	0	11	0
	The ideal group size is a)2-3 or b) 4-5 or c) >5	0	11	0
	My group's topic was a) long & complex or b) theoretical or c) applied	2	8	1
Adequacy of preparation	The amount of time that my group had spent on preparing the topic (hrs/person) was a) <2 or b) 3 or c)> 4 hrs	4	1	6
	We could have performed better in our teaching session if we had a) more instructions or b) less or c) zero instructions from the lecturer	11	0	0
	Outcomes on the topics from the lecturer were a) confusing or b) not necessary or c) useful	1	0	10

	Suggestions by the lecturer on notes that we prepared were a) confusing or b) not necessary or c) useful	1	0	10	
Effectiveness of the learning method	Other group members approached me for more explanation after my teaching session was a) 1 or b) 2-3 or c) 4 persons	3	8	0	
	The maximum amount of time that I had to spend on a topic <u>after</u> a learning session was a) >4 or b) 2-3 or c) 1 hr (s)	2	8	1	
	The number of groups that satisfactorily performed as instructors were a) 1 or b) 2-3 or c) >4	0	3	8	
Personal benefits	On the average, my interest in a topic a) decreased or b) remained the same or c) increased after being taught by other groups	0	3	8	
	On the average, my interest in a topic a) decreased or b) remained the same or c) increased after teaching other groups	0	2	9	
	The material taught by the other groups helped me in answering a) <25 % or b) 25-50 or c) 50-75% or d) >75% of the quizzes and midterm.	1	6	4	0
	When my peers were teaching, I usually paid attention for about a) <¼ or b) ½-¾ or c) >¾ of the time	0	3	8	
	This approach a) decreased or b) unchanged or c) increased my skills in dealing with group work	0	0	11	
Overall implementation	My approval rate on peer instruction as implemented in class is a) <50 % or b) 50-75% or	0	7	4	

	c) >75%			
	Our teaching session should be assessed by the a) lecturer or b)peers or c)no one	7	2	2
Information for future application	In a 50 minute lecture delivered by lecturers, I usually pay attention to the lecturers for about a) <¼ or b)½-¾ or c) >¾ of the time	1	3	7
	The number of students whom I taught was a)3 or b)4 or c) >4	4	4	3
	My suggestions for improving the teaching and learning sessions are:			