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An Analysis on the Effectiveness of Active Learning Activities for Students of Different Learning Styles in Petroleum Economics

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Abstract: Determining the most effective pedagogical technique to be used during teaching and learning activities has been one of the most challenging tasks faced by educators. Unless until educators understand how each student learns best, they may not be able to help the students to learn better. Although one can have a mix of learning styles, there would be one dominant learning style. However, one can also develop their ability and learn in their less dominant style of learning. In this research, the learning styles of the students taking the Petroleum Economics Module at Universiti Teknologi PETRONAS was assessed using the Index of Learning Styles (ILS) tool developed by Felder and Solomon. In addition, the effectiveness of conducting lessons according to the identified learning styles was also analyzed. From the ILS tool outcome, the students were further grouped according to their learning preference in the active or reflective domain. Out of 80 students, 59% have been identified to be active learners and the remaining 41% are reflective learners. Four different active learning activities namely focused listing, brain storming, pair testing and closure review pairs were implemented during lectures for four consecutive weeks throughout the semester to study the effectiveness of active learning activities among active and reflective learners. Based on the analysis conducted from the coursework and final exam marks, it was found that there is no significant evidence that active learners benefit more from active learning activities compared to reflective learners. In addition, the results suggest that active learning promotes short term memory retention for all students irrespective of learning style preference.

Keywords: active learning; learning styles; index of learning styles; petroleum economics

Introduction

Educators are still facing a strong challenge in determining the most efficient pedagogical method to be incorporated in their teaching and learning activities. According to Smith and Kosslyn (Smith & Kosslyn, 2013), knowledge is ‘the information about the world that is stored in memory’ which can be both formal and informal. Learning of new information is a structured setting whereby the student receives new knowledge and processes it. When receiving the information, the student selects the new information to be processed through their senses. During the information processing stage, the student memorizes, reasons, reflects or interact with others. Learning style can be defined as a method whereby an individual begins to concentrate, process and remember new information and skills. Students learn in different learning styles and would have one particular dominant style of learning. Learning style models have been developed to classify students according to the way they receive and process the new knowledge disseminated. Many different learning styles models have been proposed by researches according to the way learners received and process information. Similarly, teaching style models have also been proposed which allows lecturers to conduct their classes based on the learning styles of their students. The Index of Learning Styles (ILS), is a tool developed by Felder and Soloman (Felder & Soloman, 1991) to assess the learning style preference based on the four dimensions of learning style model namely active/reflective, sensing/intuitive, visual/verbal and sequential/. Identifying the right learning style of

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the students will enable the lecturer to formulate classroom activities according to the learning styles of the students.

According to Kolb (Kolb, 2014), the way a student processes information into knowledge is from active experimentation or reflective observation. Active learners are students who need to do something active such as discussing, applying or explaining the new information to others in order to retain the new information. On the other hand, reflective learners would prefer to think about the information disseminated quietly and manipulating it introspectively. In addition, active learners prefer working in groups compared to reflective learners who prefer working in isolation. However, the traditional teacher centred teaching method would not favour active and reflective learners since it requires active learners to be passive in class and reflective learners are not given sufficient time to think about the new information disseminated.

The traditional teaching method, commonly known as the "chalk and talk" approach is still widely used to deliver lectures at higher education institutions. The traditional teaching method involves the lecturers to verbally communicate the information to the students and the students passively receiving and memorizing the information (Hackathorn, Solomon, Blankmeyer, Tennial, & Garczynski, 2011). Although it is believed to be an efficient way of transferring knowledge from the lecturer to the student especially in large classroom environments, many academicians have begun to question the effectiveness of the traditional teaching method. Studies have also suggested that the traditional teaching method may not be the most effective solution to enhance student's learning ability (Bonwell & Eison, 1991; Felder & Silverman, 1988; Michel, Cater III, & Varela, 2009). In order to move beyond traditional classroom teaching and enhance the students learning experience, a student centered teaching approach has to be created. This will enable students to focus on developing and understanding difficult concepts rather than purely memorizing facts and concepts. Studies have shown that teaching techniques which encourages active student participations in classroom activities has helped in promoting critical thinking skills and better understanding of the subject matter (Bonwell & Eison, 1991; Muehlenkamp, Weiss, & Hansen, 2015; Richmond, Fleck, Heath, Broussard, & Skarda, 2015). Moreover, it was also found that students were able to retain information for a longer period of time when they participate actively during lectures (Bonwell & Eison, 1991; Lujan & DiCarlo, 2006; McCarthy & Anderson, 2000). Most importantly, most students generally appreciate opportunities to actively engage in activities during classes (Cavanagh, 2011; Machemer & Crawford, 2007).

Active learning is a student centred classroom approach to deliver lectures. According to experts in the scholarly teaching field, active learning includes any method which requires the involvement of students in the learning process itself and students are held responsible for their own learning (Bonwell & Eison, 1991; Michel et al., 2009; Yoder & Hochevar, 2005). However, active learning is not meant to replace lectures but it merely provides a medium for students to reflect, evaluate, analyse and communicate about the information gained during the lecture (Fink, 2013).Some of the common active learning methods which have resulted in enhanced learning include concept maps, collaborative writing, brainstorming, collaborative learning, one minute paper, case studies, problem based learning, team based learning, panel discussions, peer teaching and roleplaying (Zayapragassarazan & Kumar, 2012). Active learning activities are best done through a small group of two to four students (Johnson & Johnson, 2008).

In the Bachelors of Petroleum Engineering program offered by Universiti Teknologi PETRONAS, students are required to take the Petroleum Economics module in their final year of study. The course learning outcomes from this module are to describe fundamentals of petroleum economics and petroleum contracts, develop basic economic models for exploration and production projects, estimate risk factors of the projects and to conduct decision tree analysis. Just like the conventional way of teaching, students are provided with the necessary information and ideas through traditional lectures. The students are then assessed based on conventional assessments such as quizzes, tests and final exam. Coming from an engineering background, students with poor intrinsic appreciation for economics may not benefit from the traditional way of knowledge transfer from the

lecturer to the student. The aim of this research is identify the learning styles of the students and apply the most appropriate teaching approach for teaching and learning. The first specific objective of this study is to examine the effect of the identified teaching approach based on the coursework and final exam scores obtained by the students. The second specific objective of this study is to assess the memory retention of active and reflective learners when active learning activities are carried out.

Hypotheses

1. There is no difference between the mean coursework marks of active learners and reflective learners when active learning activities are conducted in class.

2. There is no difference between the mean final exam marks of active learners and reflective learners when active learning activities are conducted in class.

3. There is no difference between the mean coursework marks and final exam marks when active learning activities are conducted in class.

Research Methodology

The first part of this research consist of identifying the learning style of the students. The response of 80 students from the Petroleum Economics class were analysed using the ILS online survey instrument developed by Felder and Soloman (Felder & Soloman, 1991). The ILS tool enables the instructor to classify the students according to their learning style preferences according to four dimensions, namely active/reflective, sensing/intuitive, visual/verbal, and sequential/global. Upon completing the online survey form, a scoresheet which indicates the preference of a student to that particular dimension would be provided. The detailed analysis of the students learning styles according to the four dimensions namely active/reflective, sensing/intuitive, visual/verbal and sequential/global has been published (Kanesan, Bin Hasan, Mohyaldinn, & Vandrangi, 2018). For this research the results for the active/reflective dimensions are extracted and analysed further. The categories include students who demonstrate fairly well balanced learning style but slightly inclined towards active learning (FWBA), fairly well balanced learning style but slightly inclined to reflective learning (FWBR), moderate preference towards active learning (MA), moderate preference towards reflective learning (MR), strong preference towards active learning (SA) and strong preference towards reflective learning (SR). Figure 1 illustrates the students distribution according to their learning style in the active/reflective domain.

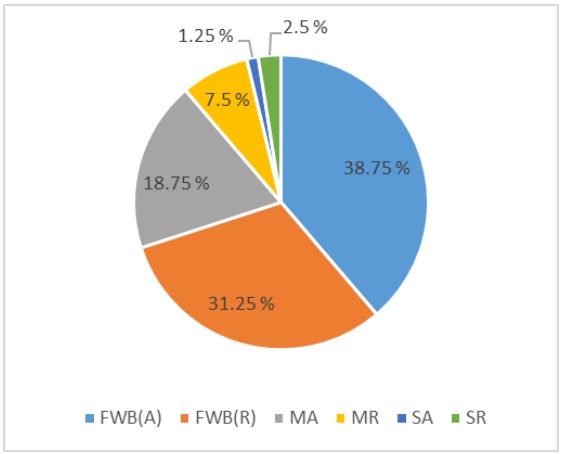

Figure 1. Students distribution according to their learning style in the active/reflective domain (Kanesan et al., 2018).

The second phase of this study consist of identifying the most suitable teaching approach, implementing the chosen teaching approach and to assess the effectiveness of the identified teaching approach based on the

coursework and final exam scores. Four suitable active learning activities were identified and implemented during lectures for four consecutive weeks throughout the semester. The active learning activities were identified based on the class size and the petroleum economics course syllabus. The four active learning activities conducted were focused listing, brain storming, pair testing and closure review pairs. The book-ends approach was used whereby the active learning activity was conducted in between a lecture. The feedback was provided to the students upon completion of the activities. To enable a representative result in the coursework and final exam results, all four active learning activities were matched to each of the four course learning outcomes for the module. In addition, the four course learning outcomes had equal weightage in terms of scores for the coursework and final exam marks. The coursework consists of quizzes, tutorials and tests which are conducted during the 14 weeks of teaching. The final exam which consist of 4 questions was conducted after a week of study break.

The independent variable in this study is the learning style of the respective students, namely active and reflective learning styles. Students were instructed to work together as a pair regardless of their learning style to complete the active learning activities. On the other hand, the dependent variable in this study is the academic achievement of the students from the active and reflective learning style groups. Throughout the semester, they were assessed with quizzes, tutorials and tests which were collectively labelled as coursework marks. In addition, to assess the memory retention aspect of active learning, the marks of the final exams which was scheduled a week after the semester ended was compared to the coursework marks.

Results and Discussion

To enable analysis of active or reflective learners as a whole, the students are further grouped according to active learners or reflective learners irrespective of the level of inclination towards active or reflective learning. Figure 2 illustrates overall grouping of the students according to the active/reflective domain.

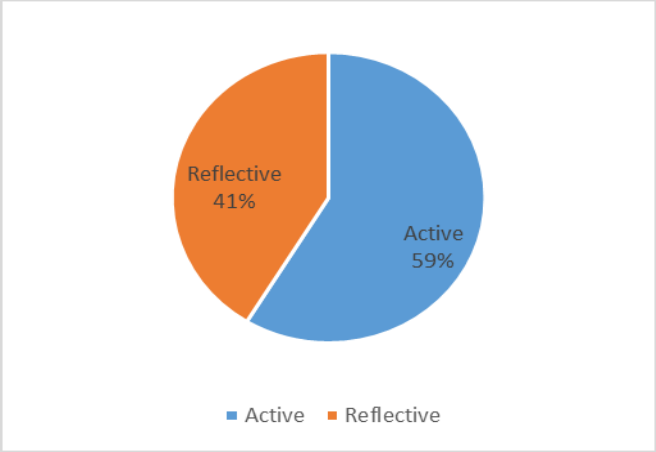

Figure 2. Overall grouping the students according to the active/reflective domain.

According to student's learning style, the effectiveness of the active learning activities was analysed. Table 1 illustrates the coursework and final exam marks of the students according to the identified learning styles. Out of 80 students, 47 of them are active learners and 33 are reflective learners. For the coursework marks, the mean value of the marks obtained by the active learners are slightly higher than the reflective learners. The results of the independent t tests for the coursework marks are reported in Table 2. From the independent t test, p value (0.818) is more than 0.05 and we fail to reject H0. We can conclude that there is no significant evidence showing active learners benefiting more from active learning activities compared to reflective learners by gaining higher coursework marks. Therefore, the results obtained supports the first hypothesis. One of the possible reason for this trend is that majority (76%) of the reflective learners fall under the FWBR category. The students from the FWBR categories are only slightly inclined towards reflective learning. This group of students

would benefit from both active or reflective learning approach. Similar findings were also found for final exam marks. The results of the independent t tests for the final exam marks are reported in Table 2. From the independent t test, p value (0.811) is more than 0.05 and we fail to reject H0. Although the reflective learners obtained higher mean value for the final exam compared to the active learners, there is no significant evidence showing that active learning activities contributes to better final exam performance for active or reflective learners. This finding supports the second hypothesis proposed. One of the possible reason for this trend is that the study conditions during the preparations for the final exams. Students often tend to study in isolation rather than actively participating in group discussion or class activities during the study week before the final exam. This environment favours the reflective learners who prefer working alone and to reflect their learning experience quietly. Next, the memory retention from active learning activities are analysed for both active and reflective learners. As shown in Table 3, the mean value for the coursework and final exam marks scored by students irrespective of the learning style are 72.75 and 67.68 respectively. The difference in the mean value between the coursework and final exam marks is 5.068. The results of the paired sample test for the coursework and final exam marks for all students irrespective of learning style are illustrated in Table 4. From the paired sample test, the p value (0.000) is less than 0.05 and we reject H0. We can conclude that the difference between mean value of the coursework and final exam is significant. It can be deduced that the active learning activities benefited the active and reflective learners for a short period of time which supports the third hypothesis proposed. The students were able to score higher for the coursework marks whereby assessments were given after each active learning activity was conducted. However, the information was not retained effectively for the final exams which was scheduled at the end of a 14-week semester. Similar to the findings of this research, Van Eynde and Spencer (Van Eynde & Spencer, 1988) also reported that there was a significant difference between the retention of student learning in near term (2 weeks) compared to long term (13 weeks) favouring the active learners.

Table 1 Overall coursework and final exam performance of the students according to the identified learning styles.

Assessment	Type of Learners	No of Students	Mean (Marks)	Std. Deviation (Marks)
Coursework	Active	47	73.05	14.88
	Reflective	33	72.33	11.78
Final Exam	Active	47	66.81	17.57
	Reflective	33	68.92	13.40

Table 2 Results of Independent sample t-tests for the coursework and final exam marks.

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Coursework	Equal variances assumed	0.479	0.491	0.230	78.000	0.818
	Equal variances not assumed			0.240	76.805	0.811
Final Exam	Equal variances assumed	1.285	0.260	-0.583	78.000	0.562
	Equal variances not assumed			-0.611	77.415	0.543

Table 3 Comparison between the overall scores irrespective of learning style for coursework and final exam marks.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Coursework	72.749	80.000	13.613	1.522
	Final Exam	67.681	80.000	15.924	1.780

Table 4 Results of the paired sample test for the coursework and final exam marks for all students irrespective of learning style.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Coursework -Final Exam	5.068	12.219	1.366	2.349	7.787	3.710	79.000	0.000

Conclusions

In the first part of this research, the learning styles of the students were identified using the ILS tool. Upon extracting the details from the active/reflective dimension the students were classified as active or reflective learners irrespective of the level of inclination towards active or reflective learning. Out of 80 students, 59% have been identified to be active learners and the remaining 41% are reflective learners. Four different suitable active learning activities, namely focused listing, brain storming, pair testing and closure review pairs were implemented for a duration of four weeks. The analysis conducted shows that there is no significant difference between the coursework and final exam marks obtained by active or reflective learners after the active learning activities were conducted. However, the higher average coursework marks for both active and reflective learners suggests that active learning activities promotes short term memory retention irrespective of learning style preference. More studies should be conducted on the effectiveness of active learning to promote better teaching and learning experience for engineering students taking elective (non-engineering related) subjects such as economics and management related subjects.

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