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How Do First Year Malaysian Chemical Engineering Students Approach Learning?

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Dynamic technology development and innovation of the 21st century have challenged chemical engineers in their working aspects. Future engineers are required to have high competitiveness in knowledge and skills in a fast changing world, requiring them to adapt and learn fast at a deep level. Consequently, education becomes a crucial means in developing matured learners who can efficiently adapt and acquire new knowledge and skills. Determining the students' approach to learning as early as possible, whether deep or surface learning, is important to assist the students in their learning. Their approach to learning can reflect their academic performance. The objective of this study is to determine the learning approach of first year chemical engineering students in a Malaysian research university. To achieve this objective, a pre-post quasi-experimental design was used to determine the approach to learning of 57 first year chemical engineering students. Revised Study Process Questionnaire (RSPQ-2F), a 20-item instrument developed by John Biggs and colleagues was used to measure the student's learning approach at the beginning and at the end of the first semester. The quantitative data were analyzed using pair-sample t-test to measure the mean RSPQ-2F scores. A p-value < .05 was considered as significant. The findings show that the students mostly use deep approach compared to surface approach to learning at the beginning of the semester. At the end of the semester, there was a slight increase in their deep approach to learning, although the increase is not significant. Similarly, there was a slight decrease in surface learning, although the decrease is not significant.

1. Introduction

Due to globalization, preparing future engineers who are highly competent in knowledge and skills has become a priority by engineering community of the 21st century. With so many technology areas emerging within chemical engineering, the changes in the conditions and job environment in the chemical engineering fields, and the demands being place in tomorrow's chemical and process engineers, what is the preparation made by the universities so that the students will be able to work in the industry? Chemical engineering is different from others engineering discipline because the design analysis occurs on process instead of products (Ziemlewski, 2009).

Many topics in chemical engineering are abstract and difficult to visualize (Huang et al., 2004). Thus, students required deep approach learning approach so that they can imagine and visualize the abstract concept. Because of that, teaching principles of chemical engineering to produce the ultimate product is one of the most innovative and continually evolving challenges (Ziemlewski, 2009). Without deep approach learning, the students have difficulties to make connection on what they are learning with their prior and existing knowledge.

Therefore, education has become a crucial means in developing matured learners who can efficiently adapt and acquire new knowledge and skills. It is clear that universities are in position to teach the students, but is the education only focusing on the teaching? Are students attending universities to be taught or to learn?

The effort to determine students' approach to learning as early as possible is important to assist the students in their learning. Their approach to learning can reflect their academic performance.

Early study in identifying students' approach to learning was initiated by Marton and Säljö (1976). Marton and Säljö (1976) conducted a study to discover how university students approached the type of task they really engaged in on a day to day basis. The students were asked to read an academic article, and they would

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afterwards be required to answer questions on it. From the findings, they identified that the surface approach is the approach in which students attempt to rote learn material in order to subsequently reproduce it, while a deep approach is the one where they seek meaning in order to understand. This is aligned with Biggs (1987) view on students' approach to learning. According to Biggs (1987), the surface approaches, consisting of concentration on superficial features of the learning task such as key words or phrases, in order to memorize or reproduce certain targeted elements. Meanwhile, the deep approach indicate by an intention to understand the material to be learnt, using strategies such as reading widely, combining a variety of resources, discussion, reflection, relating parts to a whole, and applying knowledge in real world situations.

According to Säljö (1981), the process of gaining the knowledge must be correlated with the expected outcome. Biggs (1996) agree with this suggestion by developing the constructive alignment system; a principle used for devising teaching and learning activities, and assessment tasks, that directly address the intended learning outcomes in a way not typically achieved in traditional lectures, tutorial classes and examinations (Biggs and Tang, 2007). So, this is about the process of learning. If the processes of learning vary, the outcome will vary as well.

Another aspect should be considered in determining the deep and surface approach to learning is intellectual development proposed by Perry (1970). According to Perry (1970), college students go through four stages of mental and moral develop. The four states are dualism, multiplicity, relativism, and lastly commitment. These four stages are then further divided into nine positions. Table 1 listed the descriptions of the nine positions applied to the learning situation that suggested by El-Farargy (2009). Perry's theory is especially useful because he details not only specific stages but how people arrive and change to get to each stage. College students go through four stages of mental and moral develop. The four states are dualism, multiplicity, relativism, and lastly commitment. These four stages are then further divided into nine positions.

The terms deep and surface approach usually used to describe the students. Some of the students are quicker and smarter than the others. How does the difference appear? Each learning approach has two dimensions, a motivation and a strategy. The deep motive is based on intrinsic motivation to understand, the strategy to seek meaning. The student attempts to relate the content to personally meaningful contexts or to existing prior knowledge, theorizing about what is learned and forming hypotheses. Students who possess deep learning can relate the ideas together and make connection with previous experiences. The essence of deep learning is understands where the students make sense of what they are learning (Biggs, 1990).

The surface motive is basically instrumental or extrinsic. The student's main purpose is to meet requirements with least effort resulting reproductive strategy. The students focus on what appear to be the most important topics or elements, and try to reproduce them accurately. The aims of the students are to reproduce information to meet external demands such as examinations, quizzes and test. Students who possess surface approach learning may aims to meet requirement minimally and appear to be focused on passing the assessment instead of learning.

Identifying students' learning approach as either deep or surface learner is not helpful at all. It is important to differentiate that a student's approach to learning is not permanent nor a part of a student's identity, but a measure of a student's perception of their learning environment. For this reasons, Ramsden (1992) listed environmental factors that enforce the choices of approach to learning, which are:

1. High workload encouraging rote memorization among students. Students were likely to adopt surface approach led to misconception and misunderstanding.
2. If students have a choice of what is to be learned and how, the probability of the student choose a deep approach increase.
3. Teaching which involves students in active and independent learning is more likely to encourage a deep approach to learning in the subject.
4. To possess deep approach to learning, students should prepare themselves with study and learning skills.

The objective of this study is to investigate the learning approach of first year chemical engineering students. This research provides a measure of student's perception of their learning environment, "which learning approach the first year chemical engineering students possess as their dominant approach?" The significant of this study is to help educators in recognizing their teaching styles in order to give appropriate support to the students.

Table 1: Perry's model of intellectual development as applied to the learning situation

Positions	Description	Learning position
Position 1 Basic Duality	The views of the knowledge from the students are either correct or incorrect. Knowledge is constructed as an accumulation of facts collected through the hard work	Students in this level are passive who just accept the facts only. They will obtained and understand the knowledge solely from the lecturer. Exams are viewed entirely from a factual objectives perspective
Position 2 Multiplicity Pre-legitimate	This position is about the contradicting opinions that students recognized, which they view some as correct while other as incorrect.	
Position 3 Multiplicity subordinate	Students accepted the diversity and the uncertainty, but this is only because the answer is not yet been found.	Students in this stage are in unclear situation where they need the guidance from the lecture for knowledge, assessment and grading
Position 4 Advanced Multiplicity	Students acknowledge that anyone is entitled to his or her own opinion, through whether it is right and wrong in the hand of authority.	
Position 5 Relativism	All the knowledge that viewed by the students is in contextual perspective.	In this stage, students view their lecturer as legitimate source of knowledge because they are active constructors of knowledge. The students able make an argument in different contexts and view exams as an opportunity to show and practices their skills, creativity and independent thought. Their relativistic thinking become more confident when comparing between facts and opinions
Position 6 Commitment foreseen	The students understand that it is necessary for them to be committed to a position within a relativistic world.	
Position 7 Initial commitment	The commitment is made.	
Position 8 Orientation in implications of commitment	The implication of the commitment is explored as one notions of the responsibility.	
Position 9 Developing commitment	Most of the individual situates themselves within an identity that incorporates the multiple responsibility and views commitment as an on-going process.	

2. Methodology

An exploratory study is used to investigate the learning approach of first year chemical engineering students. The sample was composed of 57 first year chemical engineering students from a university in Malaysia. This study recruited participants using purposive sampling method. According to Creswell (2012), a purposive sample suggests that the group of people chosen as participants have a specific trait that makes them suitable for the study.

To achieve this objective, one group before-after quasi experimental design was used to determine the student approach to learning. At the beginning and the end of the semester, the students were given the Revised Study Process Questionnaire (RSPQ-2F). RSPQ-2F developed by John Biggs and colleagues served as the instrument to identify the approaches to learning of student participants. RSPQ-2F consists of 20 five-point likert scale questions regarding studying techniques. The 20 items correlate into two subsets which correspond to the deep approach (questions 1, 2, 5, 6, 9, 10, 13, 14, 17, and 18) and the surface approach

(questions 3, 4, 7, 8, 11, 12, 15, 16, 19, and 20). Within these two factors, two additional sets (subscales) are identified: deep motive and deep strategy, and surface motive and surface strategy.

The Cronbach Alpha for items measuring the deep approach is 0.64 and the surface approach is 0.73, respectively (Biggs et al., 2001). Cronbach Alpha values are classified based on the classification in which the reliability index of 0.90 - 1.00 is very high, 0.70 - 0.89 is high, 0.30 - 0.69 is moderate, and 0.00 to 0.30 is low (Babbie, 1992). The Cronbach alpha values are 0.73 for deep approach and 0.64 for surface approach are considered as acceptable.

The quantitative data were analysed using pair-sample t-test analysis. Mean and significance of different values for deep approach and surface approach were calculated. A p-value of < .05 was considered as significant**.** The approach scores identified the dominant approach to learning of each participant and provided insight into how the participants perceived their learning environment.

3. Results

The mean and standard deviation Score in Students' perception on approach to learning before and after attending Introduction to Engineering course is tabulated in Table 2 and the results of t-test of significance of differences in approach to learning is tabulated in Table 3. The results in Table 3 shows that the significant different value of deep motive (p = 0.255) and deep strategy (p = 0.296) are not significant at 5 % significant level p > 0.05. The significant different values for both deep motive and deep strategy are slightly increase but not significant after the post test (refer Table 2). The significant different value of surface motive (p = 0.850) and surface strategy (p=0.409) are also not significant, p > 0.05. The mean values for both surface motive and surface strategy are slightly decrease but not significant as shown in Table 2.

Table 2: Mean and Standard Deviation Score in Students' perception on approach to learning before and after attending Introduction to Engineering course

	N	Mean	Std. Deviation
Deep motive	54		
Pre		3.4296	0.52184
Post		3.5111	0.49092
Deep strategy	54		
Pre		3.1704	0.52616
Post		3.2519	0.51423
Surface motive	54		
Pre		2.9296	0.49321
Post		2.9148	0.50746
Surface strategy	54		
Pre		2.8111	0.48435
Post		2.7444	0.56757

Table 3: Results of t-test of Significance of Differences in Students' Approach to Learning

				95 % Confidence Interval of the Difference	
	t	df	Sig. Different value (p-value)	Lower	Upper
Deep motive					
Pre	-1.150	53	0.255	-0.22356	0.06060
Post					
Deep strategy					
Pre	-1.055	53	0.296	-0.23644	0.07347
Post					
Surface motive					
Pre	0.189	53	0.850	-0.14206	0.17169
Post					
Surface strategy					
Pre	0.831	53	0.409	-0.09416	0.22749
Post					

4. Discussion

The results also show that after one semester the students' deep approach to learning was not significantly increase and the students' surface approach to learning were not significantly decrease. This is expected since approach to learning is deeply ingrained which does not only encompasses the cognitive aspects, but also the students' philosophy and behaviour, and will require more time to mature. As the first year chemical engineering students, there is a big transition of the students experience might be observed in their journey of education. The students are still adjusting their secondary school experience to the life in university. So, developing deep learning approach might take some times depending on the environment that the students face as mentioned by Ramsden (1992).

Another reason is associated with intellectual development. Intellectual development can be define as the intellectual growth of students in such a way that they become capable of understanding, analysing and evaluating a concept and make sense out of the world around them. Perry (1970) is one of the first researchers to study the intellectual development among undergraduate students. According to Perry (1970), there are nine developmental positions for university students' conceptions of knowledge, from absolute position that views the knowledge is either right or wrong to the view that all knowledge is relative. The descriptions of the nine positions applied to the learning situation were described by El-Farargy (2009).

From Perry's (1999) research, he found that most students are in Position 1 when they entered the university. He also found that most students that he teaches reached position 6 by the time they graduated. Students who are in at Position 1 of basic duality appeared to be identified with people who wield authority. The views of the knowledge from the students are either correct or incorrect. Knowledge is constructed as an accumulation of facts collected through the hard work. According to Perry (1999), students in this level are passive who just accept the facts only. They will obtained and understand the knowledge solely from the lecturer. Exams are viewed entirely from a factual objectives perspective. The results from this study is align with Perry's model of intellectual development; most students are in position one (basic duality) when they enter the university.

In addition, during that semester the students taking seven courses (Statics, Electrical Technology, Computer Programming, Academic English Skills, Mathematic Engineering, Introduction to Engineering and Seminar) with total 16 credit hours. Among the courses, only Introduction to Engineering course using Cooperative Problem Based Learning (CPBL) as teaching methods while the rest still practising traditional methods. Theoretically, teacher-centered approaches encourage students to adopt surface learning approaches, whereby learner-centered approaches promote deep learning approaches (Biggs and Tang, 2007). Having only one course applying teacher-centered approaches are not enough to urge the deep learning approach among students.

The teaching method in chemical engineering program has been quite traditional for a number of years with laboratory exercise, lectures, and calculation classes. Traditional methods provide limitations to enhance the students approach to learning into deep approach learning. One of the efforts that educators within chemical engineering had done was changing the test format. Most educators recognize that test formats will directly affect the choice of study strategies. Educators are committed to preparing questions that require high level of thinking skills. Because of that, the students discover that they cannot answer those questions with the easy information bits that they already memorize. As an alternative, the students start to study differently. It seems like this method has succeeded to enhance deep learning. The problem is, without a proper guidance, the students end up selecting deep learning approach more by accidents and less by decision (Weimer, 2012).

5. Conclusion

To help students to acquire deep approach learning, it requires balance between the instructors' support and the challenges that the students are facing. In other words, students' approach to learning is required so that they be consistently challenged and immersed in a learner-centered environment. The recommendations suggested by Culver and Hackos (1982) for learner-centered environment includes: using inquiring as an approach to learn new ideas rather than collecting facts, take risks to learn a solution from its start until completion, and use different steps to analyze various possible solution in solving complex problems that may yield multiple solutions. Therefore, by knowing the students' approach to learning, it reveals that a systematic effort should be made in all courses within the chemical engineering program so that the students can be properly supported in a learner-centered environment to shift their approach to deep learning.

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