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MOTIVATION AND PERFORMANCE IN LEARNING CALCULUS THROUGH PROBLEM-BASED LEARNING

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ABSTRACT
Problem-based learning (PBL) as a student centered and active learning strategies can be used to improve students' motivation, interests and often lead to deep level learning outcomes in calculus to enrich performance. Objectives of this study are to (i) identify students' level of motivation in learning calculus based on instruction strategies (PBL and traditional) and; (ii) establish relationship between levels of motivation and students' test achievement. A group of 42 Foundation Year engineering students was randomly selected to undergo the PBL (n=24) and traditional (n=18) approach in Basic Calculus course. Data was gathered through the instrument based on the ARCS (Attention, Relevance, Confidence and Satisfaction) model and a post-test (Calculus Achievement Test) to measure students' motivation and performance respectively after undergoing learning approach. Findings showed that there were only significant difference in students' motivation attention (M=3.98, SD= .486; t (40) =3.905, p=0.000), relevance (M=4.36, SD= .365; t (40) =4.340, p=0.000) and satisfaction (M=3.53, SD= .436; t (40) =2.894, p=0.006) by using PBL as compared to traditional approach. Respondents with higher achievement in test obtained higher overall scores for motivation. Significant positive correlations were established between attention, satisfaction and overall motivation with students' test achievement. This finding suggests that active learning strategies could be used to motivate students in teaching and learning calculus for engineering students.

Keywords: Mathematics Education, Motivation, Calculus, Problem Based Learning

1. INTRODUCTION

Calculus is one of the most important subjects for science and engineering students in university to pursuing their study. However many students cannot achieve a deep understanding and find that calculus is very hard to learn, boring and abstract subject (Zhang, 2003; Zhou, 2002). Many students question why they should learn calculus and how calculus would be useful in their future work after graduation. Since calculus viewed as a difficult and dull subject, it make student demotivated and not enjoy in learning calculus. When students don't enjoy learning, they are less likely to show interest and effort toward achievement, and more likely to perform poorly and drop out of class. The lack of motivation in students is one of the primary causes they are perform lower than expected. If this lack of motivation is not dealt with seriously, it can lead to more severe problems in the future (Ryan, 1995).

Underpinning with in constructivism theories, problem-based learning (PBL) is one of student centered and active learning strategies or approach which can be used to improve students' interests and often lead to deep level understand hence acquiring the learning outcomes of a course (Zhou, 2002; Savery & Duffy, 1995). In contrast to conventional calculus classroom environments, a PBL environment provides students with opportunities to develop their abilities to adapt and change methods to fit new situations. Further, students in PBL environments typically have greater opportunity to learn mathematical processes associated with communication, representation, modeling, and reasoning (Erickson, 1999; Lubienski, 1999).

In PBL the problem becomes the instrument for learning. Students are highly motivated to learn as the focus is no longer for the sake of school but they face real life problems and the learning is inevitable when solving these problems (Kain, 2003). Students taught in traditional mathematics education environments are preoccupied by exercises, rules, and equations that need to be learned, but are of limited use in unfamiliar situations such as solving real-life mathematics projects.

2. MOTIVATION

Motivation is defined as deciding to engage in a learning task and persisting in that task (Driscoll, 1993). Motivation is a core construct in human behavior. Some have said that motivation is emotion in motion. Motivation is a psychological process that gives purpose, direction and intensity to behavior and that it is mainly responsible for differential work output (Mwangi & McCaslin, 1995). It propels and directs learners to engage in academic activities and determines how much is learnt from such activities, and from other information sources to which learners are exposed (Slavin, 1997). Motivated learners are able to use higher cognitive processes to learn, absorb and retain more from the subject (Graham & Golan, 1991). They strive to understand the subject matter, improve performance, seek challenges and persist at tasks even in the face of failure (Woolfolk, 2008).

Motivation to learn may be intrinsic or extrinsic (Biehler & Snowman, 1997). Individuals with intrinsic motivation respond to internal needs such as personal interest in a subject, satisfaction or enjoyment in a learning task that is inherently interesting while those with extrinsic motivation respond to external rewards. Such rewards include a teacher's praise and approval of their participation in a lesson, encouragement and positive feedback on task performance. During instruction, a teacher's task is to discover, initiate and sustain students' motivation to learn and to encourage them to engage in learning activities (Salvin, 1997). Teachers and classroom environments can affect student motivation in significant ways. When instruction is meaningful, challenging, and affords a degree of choice, students are more likely to be engaged than when instruction lacks these features. In addition, students are more likely to participate when they establish positive social relationships and feel valued (Byrnes, 2001).

The four dimensions of motivation to learn that are the focus of this study are interest to attention, relevance, expectancy of success or confidence, and satisfaction. Interest arouses a learner's curiosity to learn, respond and attend to subject matter. Attention and confidence are relevant and important in the teaching and learning of calculus. The attention factor captures the interest of learners and stimulates curiosity to learn, which an essential component in learning calculus. The confidence factor will help the learners to believe that they will be able to control their successes. Perceived probability of success, expectancy of success or confidence is the learners' perceived likelihood of success through their personal control of their behavior. Learners will try harder to learn the material if they think they are likely to pass the subject. Relevance is the extent to which learners perceive subject matter content to be significant and valuable to them. If they consider the material to be relevant, they will try to learn it. Satisfaction is the learners' psychological equilibration due to experience of extrinsic rewards and realization of intrinsic growth needs (Keller,2007; Keller, 2010).

3. METHODOLOGY

Manuscripts Objectives of this study are to (i) identify students' level of motivation in learning calculus based on instruction strategies (PBL and traditional) and; (ii) establish relationship between levels of motivation and students' test achievement and; (iii). The subjects of the survey were selected among first year students have taken basic calculus subject. The questionnaire was self-administered and data from 42 first year students were collected of which are divided to two groups to undergo the PBL (n=24) and traditional (n=18) approach in Basic Calculus course. Data was gathered through the instrument based on the ARCS (Attention, Relevance, Confidence and Satisfaction) model and a post-test (Calculus Achievement Test) to measure students' motivation and performance respectively after undergoing learning approach.

Keller's (2010) Course Interest Survey (CIS) was used in this study to measure students' motivation towards in calculus class. The CIS has 34 items divided into four categories: Attention, Relevance, Confidence, and Satisfaction. Survey items in the attention category measure the extent to which the interest of learners is captured and their curiosity to learn is stimulated by the lesson. Items in the relevance category serve to measure the extent to which the personal needs and goals of the learner are met in such a way as to affect a positive attitude. Items related to confidence evaluate the perception of learners about whether they will be able to succeed and control their success. Finally, the items in the category of satisfaction measure the extent to which student accomplishments are reinforced. Cronbach's alpha coefficient for the CIS is .95. Alpha coefficient values for the subscales are: .84 for Attention, .84 for Relevance, .81 for Confidence, and .88 for Satisfaction (Keller,2010).

4. FINDINGS

This section, findings are presented based on the objectives of the research. An independent-samples t-test was conducted to compare the differences in subscale motivation survey score (Attention, Relevance, Confidence, and Satisfaction) and achievement score based on instructional strategies. Pearson correlation analysis was used to establish relationship between motivations with calculus achievement.

Table 1 displays the mean scores on the subscale motivation survey and t-test result based on instructional strategies. Findings showed that there were significant difference in students' motivation attention (M=3.927, SD= .486; t (40) =3.905, p=0.000), relevance (M=4.36, SD= .365; t (40) =4.340, p=0.000) and satisfaction (M=3.53, SD= .436; t (40) =2.894, p=0.006) by using PBL as compared to traditional approach. However, no significant difference was found in students' confidence. For overall motivation, the finding showed that there was a significant difference between the motivation of students using PBL (M=3.86; SD = 0.311) as compared to the traditional approach (M= 3.42; SD= 0.317; t (40) = 4.510, p=0.000).

Table-1. T-Test of Motivation (Attention, Relevance, Confidence, and Satisfaction) Mean Scores Based on Instructional Strategies

Independent Samples Test – Instructional Strategies								
	Strategies	**N**	**Mean**	**Std. Dev**	**t**	**df**	**p**	**Mean Diff**
Attention	PBL	24	3.927	.5106	3.839	40	.000	.57292
	Traditional	18	3.354	.4314				
Relevance	PBL	24	4.361	.3652	4.340	40	.000	.60185
	Traditional	18	3.759	.5339				
Confidence	PBL	24	3.609	.4504	1.564	40	.126	.21354
	Traditional	18	3.396	.4206				
Satisfaction	PBL	24	3.528	.4362	2.894	40	.006	.36728
	Traditional	18	3.160	.3640				

Overall Motivation	PBL	24	3.862	.3117	4.510	40	.000	.44158
	Traditional	18	3.420	.3172				

Table-2. Achievement Category by Instructional Strategies

Cross tabulation Achievement Category by Instructional Strategies				
		Strategies Groups		Total
		PBL	Traditional	
Achievement Categories	High	16 38.1%	5 11.9%	21 50.0%
	Medium	8 19.0%	12 28.6%	20 47.6%
	Low	0 .0%	1 2.4%	1 2.4%
Total		24 57.1%	18 42.9%	42 100.0%

The respondents' motivation scores by subscale and overall were also analyzed based on their grade achievement in calculus test. Grade achievement was categorized as High (for A, A- and B+), Medium (for B, B- and C+) and Low (for C, C- and D). Cross tabulation achievement category by instructional strategies as show in Table 2. Table 3 below shows the distribution of mean based on achievement categories. It seems that respondents with higher grade obtained higher scores in all subscale of motivation. Respondents in the high achievement category scored the highest in all subscale of motivation; Attention (M = 3.857, SD = 0.581), Relevance (M = 4.222, SD = 0.543), Confidence (M = 3.367, SD = 0.473), and Satisfaction (M = 3.497, SD = 0.408).

Table-3. Level of Motivation by Achievement Category

Descriptive											
Achievement	N	Attention		Relevance		Confidence		Satisfaction		Overall Motivation	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
High	21	3.857	.5813	4.222	.5432	3.637	.4725	3.497	.4077	3.807	.3908
Medium	20	3.525	.4775	3.995	.5180	3.406	.4012	3.261	.4521	3.552	.3292
Low	1	3.125	.	3.778	.	3.250	.	2.889	.	3.265	.
Total	42	3.682	.5530	4.103	.5328	3.518	.4457	3.370	.4422	3.672	.3810

Table-4. Correlations between subscale of Motivation and Overall Motivation with Students' Calculus Achievement

Pearson Correlation					
	Attention	Relevance	Confidence	Satisfaction	Overall Total Motivation
Pearson Correlation	.304	.273	.292	.363*	.397**
Sig. (2-tailed)	.050	.080	.061	.018	.009
N	42	42	42	42	42

The Pearson correlation analysis was used to establish relationship between scores in the survey with calculus test achievement. Positive correlations are established between subscale of motivation; attention (.304, $p = .050 > .05$), relevance (.273, $p = .008 >.05$), confidence (.292, $p =.061$), satisfaction (.363, $p =.018 < .05$) and overall motivation (.397, $p = .009 < .05$) with students' calculus achievement as shown in Table 4. Only subscale satisfaction are significant correlations.

Table-5. T-Test of Achievement Scores Based on Instructional Strategies

Independent Samples Test – Achievement Score by Instructional Strategies								
	Strategies	**N**	**Mean**	**Std. Dev**	**t**	**df**	**p**	**Mean Diff**
Achievement	PBL	24	79.15	7.06	2.77	40	.008	7.55
	Traditional	18	71.60	10.59				

Table 5 displays the mean scores on the calculus test and t-test result based on instructional strategies. An independent-samples t-test was conducted to compare the performance in Calculus Achievement Test between treatment group (PBL group) and control group (TRAD group), to support the correlation analysis result. There was significant difference in calculus test achievement PBL group (M= 79.15, SD = 7.06) and traditional group (M= 71.60, SD = 10.59); t (40) = 2.77, p = 0.008 < 0.05).

5. DISCUSSION AND CONCLUSION

This study was to seek students' motivation in using PBL and traditional instructional strategies. For that purpose, the ARCS model was used to investigate students' motivation. By using this model, researchers could identify and understand how students' motivation could change over time. In addition, researchers also investigate among all four ARCS components to optimize the findings.

Overall finding showed that there was a significant difference between the motivations of students using PBL as compared to the traditional approach. This study showed that students' motivation in subscale attention, relevance, confidence and satisfaction are higher by using PBL approach compared to traditional approach. Study also found that respondents with higher achievement obtained higher scores in all subscale of motivation. This findings support findings of Middleton and Spanias' (1999) study which concluded that success in mathematics is a powerful influence on the motivation to achieve. Pearson correlation analysis showed that relationship between calculus test achievement and all subscale motivation are positive correlations. This study proved that PBL is more effective method of instruction for creation of interest and motivation in calculus as compared to traditional method of teaching. Teachers of mathematics should use PBL method to improve the academic achievements of the students.

There is no single magical formula for motivating students. Many factors affect a particular student's motivation to work and to learn such as interest in the subject matter, perception of its usefulness, general desire to achieve, self-confidence, self-esteem as well as patience and persistence (Bligh, 1971). Motivations play an important role in student learning and achievements because it intimately related to the ways of students thinks, feels, and act. Evidence from research on student learning in mathematics and science demonstrates that students' motivation, affect, strategies, and beliefs can influence their learning and performance (Pintrich & Schunk, 2002; Pintrich & Maehr, 2004),

In making instruction interesting in learning mathematics, there is need to use methods/strategies and material/media which will make the learning of mathematics, active, investigative and adventurous as much as possible. PBL environment provides both intrinsic and extrinsic motivation. Problems provide opportunity to the students to take risks, to apply knowledge, to adopt new understanding, and to experience the thrill of being discoverers. (Riasat Ali et ll 2011). PBL approach, student face with authentic task that is meaningful, interesting and has connection with real-life situation (Woolfolk, 2008). Student in PBL groups are more motivated, cooperative and learn from each other.

REFERENCE

Bierhler, R. and Snowman, J. 1997. Psychology applied to teaching. 8th Edn. Boston: Houghton-Mifflin.

Bligh, D. A. 1971. What's the use of lecturing? Devon, England: Teaching Services Centre, University of Exeter, 1971.

Byrnes, B. 2001. Cognitive development and learning in instructional contexts. Allyn and Bacon: Needham Heights, M.A.

Driscoll, M. P. 1993. Psychology of learning for instruction. Needham Heights, MA: Allyn & Bacon.

Erickson, D. K. 1999. A problem-based approach to mathematics instruction. Mathematics Teacher, 92(6): 516-521.

Graham, S. and Golan, S. 1991. Motivational influences on cognition: Task involvement, ego involvement, and depth of information processing. Journal of Educational Psychology, 83(2): 187-196.

Kain, Daniel L. 2003. Problem based learning for teachers, grades K-8. New York: Allyn & Bacon.

Keller, J. M. 2007. Motivation and performance. In R. A. Reiser & J. V. Dempsey (Eds.), trends and issues in instructional design and technology. 2nd Edn. Upper Saddle River, NJ: Pearson Education. Pp: 82-92

Keller, J.M. 2010. Motivational design for learning and perfomance: The ARCS Model Approach; Springer Verlag.

Lubienski, S. T. 1999. Problem-centered mathematics teaching. Mathematics Teaching in the Middle School, 5(4): 250-255.

Middleton, J.A, and Spanias, P.A. 1999. Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. Journal for Research in Mathematics Education, 30(1): 65-88.

Mwangi, J. G. and McCaslin, N. L. 1995. Factors related to the motivation of extension agents in Kenya’s Rift Valley Province. Journal of International Agricultural and Extension Education, 2(1): 16-25.

Pintrich, P. R. and Schunk, D. H. 2002. Motivation in education: Theory, research, and applications. 2nd Edn. Columbus, OH: Merrill-Prentice Hall.

Pintrich, P.R. and Maehr, M.L. 2004. Advances in motivation and achievement: Motivating students, improving schools, 13. Oxford, England: JAI, An Imprint of Elsevier Science.

Riasat Ali, Aqila Akhter, Saqib Shahzad, Najma Sultana, Muhammad Ramzan, 2011. The impact of motivation on studemts' academic achievement in mathematics in problem based learning environment. International Journal of Academic Research, 3(1): 2011.

Ryan, R.M. 1995. Psychological needs and the facilitation of integrative processes. Journal of Personality, 63(3): 397-427.

Savery, J. R. and Duffy, T. M. 1995. Problem-based learning: An instructional model and its constructivist framework. Educational Technology, 35(5): 31–38.

Slavin, R.E. 1997. Educational psychology theory and practice. Boston: Allyn and Bacon.

Woolfolk, A. 2008. Educational psychology: Active learning edition, 10th Edn. Boston; Pearson Education, Inc.

Zhang, B. 2003. Using student centered teaching strategies in calculus. In M. Peat (ed.) The China Papers: Tertiary Science and Mathematics Teaching for the 21st Century, **2**: 100-103

Zhou Yuan, 2002. Improving the qualities of teaching calculus - by modern education theories and modern technology, In M. Peat (ed.) The China Papers: Tertiary Science and Mathematics Teaching for the 21st Century, 1: 23-27.