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The Effects of Concrete-Pictorial-Abstract (CPA) Teaching Method on the Malaysian Community College Students' Attitude towards Geometry

(Kesan Kaedah Pengajaran Konkrit-Gambar-Abstrak (KGA) ke atas Sikap Pelajar Kolej Komuniti Malaysia terhadap Geometri)

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ABSTRACT

Community college is an institution that provides training and skills for post-secondary education leavers to become skilled workforce with minimum enrolment requirements. However, the admission of students who possessed low basic knowledge of Mathematics has somehow affected the Geometry teaching and learning process. These students show less interest and attitude in learning Mathematics. This quasi-experimental study aimed to investigate the effect of the CPA teaching method on Malaysian Community College students' attitudes towards Geometry. A total of 60 students who registered their first semester Mathematics module from Pulau Pinang and Kedah Community Colleges was selected as samples. The control group used the conventional method (non-CPA), while the experimental group used concrete-pictorial-abstract (CPA) method. Questionnaires were used as the instrument. Data were analyzed using one-way ANCOVA. It was found that there are significant differences in attitude towards Geometry between the control and experimental group. This result provides positive effects on the implementation of CPA approach in the teaching and learning of Geometry. This study hence suggests that educators in Malaysia to integrate CPA teaching methods in their teaching and learning process of Geometry, which will have a better implication on the attitude of students studying Geometry.

Key Words: Geometry; Concrete-Pictorial-Abstract; Teaching Method; Attitude

ABSTRAK

Kolej Komuniti merupakan institusi yang menyediakan keperluan latihan dan kemahiran kepada lepasan menengah ke pasaran tenaga kerja berkemahiran dengan syarat pengambilan yang minima. Namun, kemasukan pelajar tanpa ilmu Matematik asas yang kukuh menjadikan proses pengajaran dan pembelajaran Geometri menghadapi kekangan. Pelajar ini tidak menunjukkan minat dan sikap yang baik dalam mempelajari Matematik. Kajian eksperimen kuasi ini bertujuan untuk mengkaji kesan kaedah pengajaran konkrit-gambar-abstrak (KGA) terhadap sikap pelajar Kolej Komuniti Malaysia terhadap Geometri. Seramai 60 orang pelajar yang semester satu yang mendaftar modul Matematik dari Kolej Komuniti Pulau Pinang dan Kedah telah dipilih sebagai sampel. Kumpulan kawalan menggunakan kaedah konvensional (tanpa KGA), manakala kumpulan eksperimen menggunakan kaedah konkrit-gambar-abstrak (KGA). Soal selidik digunakan sebagai instrumen Data dianalisis menggunakan ujian ANCOVA satu hala. Dapatan emenunjukkan terdapat perbezaan signifikan terhadap sikap pelajar terhadap Geometri antara pelajar yang mengikuti kaedah KGA dan pelajar yang mengikuti kaedah konvensional. Dapatan kajian ini menunjukkan kesan positif terhadap pelaksanaan pendekatan KGA dalam pengajaran dan pembelajaran Geometry. Kajian ini mencadangkan para pengajar di Malaysia untuk menintegrasikan kaedah pengajaran konkrit-gambar-abstrak dalam proses pengajaran dan pembelajaran Geometri yang mana ianya bakal memberi implikasi yang lebih baik terhadap sikap pelajar dalam mempelajari Geometri.

Kata Kunci: Geometri; Konkrit, Gambar, Abstrak; Kaedah Pengajaran; Sikap

INTRODUCTION

The current era of technology advancement requires people with a multidisciplinary of knowledge and ability to apply mathematical skills in everyday life due to its important role in helping human success (Koh et al. 2008; Sneideman 2013). Therefore, Mathematics learning should be taken seriously by the Community College students which has average achievement in Mathematics course, SSM1022 (Unit Peperiksaan Kolej Komuniti Seberang Jaya 2015). According to the *Unit Peperiksaan Kolej Komuniti Seberang Jaya* records, it

was revealed that students' Mathematics course achievement was at a low and moderate level. Hence, it was feared that these students may have to face negative impact in their education advancement to a higher level because what has been learned in community college only involves basic topics which are namely Quantity and Basic Units, Measurements, Algebraic Equations and Linear Equations (Community College Education Department 2015). Geometry is one of the subtopics in the second chapter of Mathematics course with SSM1022 course code for students enrolled in Electrical Installation Certificate. It constitutes 4-hours of lecture period designating its own importance for the Community College students.

Through the Mathematics course curriculum with SSM1022 course code, the Geometry topic is actually divided into two subtopics that are two-dimensional Geometry and three-dimensional Geometry. It is important for the students to understand the basic of two-dimensional Geometry because the student's inability to comprehend it will cause the learning of three-dimensional Geometry later on be more complicated. The two-dimensional Geometry has been proven to be important by only looking through how it has been heavily emphasized in the school curriculum as an effort to solidify student visualization on this topic (Christou et al. 2006; Bokhove et al. 2019).

Community College students enrolled in Certificate of Electrical Installation generally assume Mathematics as a difficult and complex course. They have shown low interest for this course whereas it is actually an important knowledge that need to be mastered and used in daily life (Noraini 2005; Harris 2019). Mathematics subject is one of the mandatory courses required by students of Community College Certificate of Electrical Installation with the SSM1022 course code, but this course becomes a burden to these student as they are mostly fail and possess minimal result for Mathematics subject in the SPM. It was stated by Johari (2006) in his study that the achievement of Mathematics among students has declined lately and reported by Salam et al. (2019) regarding to low Mathematics learning outcomes were also experienced by 11th-grade students in a Senior High School.

The achievement of the final semester Mathematics examination also involves the subtopic of the two-dimensional Geometry which is a compulsory question in each set of final exams (Unit Peperiksaan Kolej Komuniti Seberang Jaya 2015). Hence, it is important for the students to understand the subtopic of the two-dimensional Geometry as well as it may help students to be more successful in Computer Aided Drawing (CAD) course for their second semester (Community College Education Department 2013). This has led an initiative to be taken in order to assist these students to go through the selection of appropriate and effective teaching and learning delivery techniques, who is believed to prefer work-based session (Beres 2011) by trying to improve their attitude towards Mathematics.

Numerous teaching methods have been used by the teachers in order to change the students' attitude and spirit positively towards Mathematics, one of it is the Concrete-Pictorial-Abstract (CPA) method. Research on CPA methods in the teaching and learning process to determine the impact on student academic achievement have not been widely applied in Malaysia, especially application to Geometry subtopic. However, CPA have been adopted as one of the methods frequently used in Singapore, as noted in the study of Leong et al. (2015). Research on the approach of the CPA teaching method has been carried out in Singapore and even the use of the CPA method shows the effect of its implementation in the teaching and learning process to help Mathematical learning and showed positive developments (Leong et al. 2015).

This study aimed to determine the difference in attitude towards Geometry between students who follow the CPA method and students who follow conventional method.

Attitude Towards Learning Mathematics

Students' attitudes toward a learning topic generally refer to the attitude of the student whether it will be positive or negative towards the topic during the course of teaching and learning. The use of teaching approaches and teaching aids that are appropriate during the learning process will be able to develop a more positive attitude toward a learning topic including Geometry. According to Arsaythamby (2010), the variables of Mathematics learning attitudes have significant positive correlations with Mathematics achievement. This is also supported by Abdul Halim and Effandi (2011) which stated that the negative attitudes of students towards some topics in Mathematics including Geometric topics will affect student's achievement. In this regard, it is important to build a positive attitude towards a learning topic as an effort to improve student's achievement.

Based on the findings of the relevant studies, most have shown that students could not see and understand the importance of Geometry in their daily life as well as the importance of learning it (Hussein 2010). The results of Almeida's (2000) study in Hussein (2010) showed that Swedish students generally possess positive attitude towards Geometry, but they had negative feedback towards Geometric. It was proven when they mentioned "I can't see the significance of proving whereas all have been proven without a doubt by famous Mathematician".

The Yang and Tsai study (2010) stated that interrelationships between the attitude and approach of teaching methods used in the teaching and learning

process will also affect the learning achievement of which this statement is in line with the findings of Pilli and Aksu (2013). This shows that students' attitudes toward the learning of a subject can be changed and positively developed by lecturers who teach the students through the appropriate teaching method.

From Lawsha and Hussain (2011) study, it was found that maximum effort must be done to improve student attitudes towards Mathematics, which is then supported by Farooq and Shah (2008). They stated that students' attitude will lead to their perception of Mathematics. Generally, students' attitude leads to their success in learning a subject. In other words, a good attitude encourages good achievement, and that good experience can help to develop positive attitudes and perceptions towards subject learning in the future.

BRUNER'S LEARNING THEORY AND THE CONCRETE-PICTORIAL-ABSTRACT (CPA) METHOD

Jerome Seymour Bruner is a psychologist that provides thought on human cognitive development on how people learn and transform knowledge including the three modes of presentation namely as enactive (action-based), iconic (image-based) representation and symbolic representation (language-based). Bruner's theory suggests that when human faced with the presentation of new information, the learning process follows from enactive to iconic representation then goes to symbolic representation, the learning process is effective even on adult learners. Bruner also suggested that a student even at a very young age would be able to learn new things as long as the instruction given was appropriate and orderly, in which his beliefs different from Piaget's beliefs and other theories (Bruner 1977).

From Bruner opinion on the process of learning, human cognitive development had three levels: the enactive level, the iconic level and the symbolic level (Leong et al. 2015). Each of these levels is sequence of which one must go through an enactive level to understand something by using psychomotor knowledge that is through touching, holding and other activities. At the iconic level, one understands the objects or his world through visions for examples through pictures or verbal visualization. Then at the symbolic level, one will understand the world through the symbols of language, logic, Mathematics and others. Some studies have been documented using concrete, pictorial and abstract representation concepts in teaching and learning processes that shown this approach can improve understanding among students (Butler et al. 2003; Donaldson & Zager 2010; Eastburn 2010; Stroizer et al. 2015; Witzel 2005).

A study by Flores (2010) has used the sequences of concrete, representation and abstract (CRA) to teach calculations. Her research was conducted on six students that were in their third grade. She combines the use of ten basic blocks and pictorial representations that represent the concrete level and level of the representation. Then, Flores uses the DRAW command: Discover the sign, Read the problem, Answer or draw and check, and Write the answer; this command requires the student to identify the operation marks, read the problem, answer or draw and check then lastly write the answers. He has practiced cognitive strategies with gradual teaching sequences. The results from Flores' study showed that all six students met 80% or higher accuracy performance criteria and only four out of six students retained the level of criteria after six weeks did not receive any instructions.

The CPA method is based on the Bruner Theory which is highly structured and consists of three levels; concrete, pictorial and abstract. The learning of a human being extends from the motor-sensory stage to the pictorial response stage and eventually to the abstract of idea. Therefore, teaching should also grow in the sequence and lessons need to be planned in order to help human gain experience at first, then respond with concrete delivery and eventually present in symbolic form. An example of a learning situation in this order is at the concrete level, when a child is trying to ride a bicycle and then in the pictorial level is when the child can figure out or imagine on how to bike well. Finally, at the abstract level is when these children were able to relate their experiences in cycling to their peers. CPA method will be able to stimulate students' ability to solve problems using their knowledge and skills as well as applying them in the real-world situations (Leong et al. 2015).

Mancl et al. (2012) conducted a similar study to Flores (2010) that explored the effects of teaching subtraction using method of regrouping which also used the sequences of concrete, pictorial and abstract in the teaching and learning process involving five students with disabilities in an elementary school. This study yielded results similar to the findings of Flores (2010). The results reported by Mancl et al. (2012) indicate that all five students met performance criteria of 80% or higher and all of these students maintained their skills at the level of the criteria a week later. The finding from Hafiziani (2015) and Purwadi et al. (2019) also supported that CPA method can improved students understanding.

METHODOLOGY

RESEARCH DESIGN

The study used the quasi-experimental design with non-equivalent groups pre-test post-test design. The participants in this study were divided into experimental group (CPA method) and control group (conventional method) (Gay et al. 2012). The design of this study can be summarized as in Table 1.

Two-dimensional Geometry is a subtopic of Mathematics with SSM1022 code modules. This subtopic is in the second chapter of the latest syllabus in the modules that currently being used in Community College throughout Malaysia (Community College Education Department 2015). It is taken from the actual syllabus and the process of teaching and learning has indeed been planned by Community College. The control group went through conventional teaching methods planned by the Community College.

The experimental group went through a modified teaching plan, with incorporations of CPA method. The CPA method was incorporated into the Geometry daily lesson plans but maintaining the learning objectives, learning outcomes and duration of the conventional method. The modifications done were reviewed by two panel with experienced in teaching Mathematics. The review was made in order to conform the description and objectives of the learning with the research.

This research has obtained ethical approval by the Community College Education Department, Ministry of Higher Education Malaysia (Reference: KPT/JPKK/BPA/650-6/2 Jld.4 (73)). The consent to conduct this study has been obtained from the university, the ministry, and the community college administrator where this study was conducted.

POPULATION & SAMPLE

The population of this study comprised of first semester technical students of Malaysian Community College majoring in Electrical Installation Certificate in Northern Malaysia. In total, there are four Community Colleges that offer Electrical Installation Certificate in the Northern Malaysia (Community College Education Department 2016).

From the population, two Community Colleges were chosen using cluster sampling technique to reduce time for the sample selection process. From the two Community Colleges, 60 students were randomly selected as samples from a total of 120 students. All the students have gone through the same formal schooling until Malaysian Education Certificate (SPM) level, and some of these students have poor Mathematics results. They were divided into two classes, in which each of these classes has the same number of students (30 students per class from each college). Table 2 shows the number of students involved in the control and experimental groups.

TABLE 1. Research Design

Experimental group	Q_1	X_1	Q_2
Control group	Q_1	X_2	Q_2

Indicators:
X_1 = CPA Teaching Method
X_2 = Conventional Teaching Method
Q_1 = Pre Attitude Questionnaire
Q_2 = Post-test score

TABLE 2. Number of students involved in each group

Group	Teaching Method	Number of Students		Total
		Male	Female	
Experimental	CPA Method	28	2	30
Control	Conventional Method	28	2	30
Total		56	4	60

DATA COLLECTION AND ANALYSIS METHOD

This study used the questionnaire by Norila (2009) based on ATMI, namely as Attitudes Towards Mathematics Inventory developed by Martha Tapia (1996) as the pre-test and post-test instrument to collect data on students' attitudes towards Geometry.

The questionnaire for this study has 38 items representing 4 subscales of attitude, which were i) self-confidence, ii) value, iii) excitement, and iv) motivation that used 5-point Likert Scale in range of 1 to 5 where 5 points are given for "Strongly Agree" while 1-point value is for "Strongly Disagree" answer choice. For other scores of 2, 3 and 4, respectively, representing the "Disagree", "Indefinite" and "Agree". The attitude to be measured is to cover these four aspects as a whole related to finding solutions to Mathematics issues, especially in the Geometric topics.

In Norila's (2009) study, appropriate items selected and modified accordingly, and then it was translated from English to Malay through a back translation process based on the ATMI item. It also underwent a construct validity and reliability test that resulted Cronbach alpha of 0.96. The validity of the items in this questionnaire conducted by two experienced panelists for at least 15 years in related area that were a lecturer from the Community College and a specialist in Mathematics Education.

The data for this study were analyzed using one-way ANCOVA to test the effects of the independent variable (teaching methods) on the dependent variable (post-test scores). The independent variable in this study was the teaching methods used (CPA and conventional methods) and the dependent variable was

the pre-test and post-test scores of the students' attitude questionnaire, with pre-test scores as the covariates.

FINDINGS AND DISCUSSION

A normality test was conducted on both groups' pre-test scores to determine whether the pre-test scores fulfil the assumptions of the independent samples t-test. It was found that both the experimental and control groups' pre-test scores are assumed to be normally distributed in the population ($p>.05$).

To determine the differences in the variance of the two groups, an independent sample t-test was conducted on the pre-test questionnaire. From the result, the Levene's Test shows a value of $p = .03 < .05$, it resulted that the pre-test test scores for the control (conventional) and experimental (CPA) test groups have inconsistencies in the population. Therefore, the second row of unequal variance (equal variances not assumed) in the independent sample t-test decision table referred and the results of the independent sample t-test revealed that there were differences in pre-test questionnaire.

As the results of the independent sample t-test showed that there was a difference in both groups' pre-test scores, therefore the ANCOVA analysis was done to statistically control the differences (as shown in Table 5). The findings show that the post-test score of the experimental group (M=3.91) was higher than the post-test score of the control group (M=3.61). Therefore, this shows that the use of CPA teaching methods and conventional teaching methods affects students' attitudes towards Geometry.

The analysis showed that the post-test score of the experimental group (CPA method) was significantly higher than the post-test score of the control group (conventional method). This shows that the students who experienced the CPA method in learning Geometry shows a significant increase in attitude towards Geometry, compared to students who learn using conventional methods.

The CPA teaching method able to improve student attitude towards Geometry that related to students' self-esteem, enjoyment, values and motivation compared to students who experienced conventional methods (non-CPA teaching methods). The findings of this study also shown that the variables of a learning attitude related to the achievement of such learning as stated by Arsaythamby (2010). In this study, it was found that there is an increased in student Geometry achievement in line with the overall student attitude score resulting from the used of CPA teaching method approach in the teaching and learning Geometry. This finding supported by Abdul Halim and Effandi (2011) statement that student attitude is related and influenced the achievement of the student which is in order to get good achievement then the student should have positive attitude.

TABLE 3. The Normality Kolmogorov-Smirnov Test for pre-test scores between experimental and control group

Teaching Method	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CPA	.15	30	.08	.95	30	.21
Conventional	.12	30	.20*	.97	30	.52

TABLE 4. The Independent Sample t-Test for pre-test scores between experimental and control group

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	5.06	.03	-2.25	58	.03	-.28	.12	-.52	-.03
Equal variances not assumed			-2.25	44.80	.03	-.28	.12	-.52	-.03

TABLE 5. One-way ANCOVA analyses for the difference in post-test scores between experimental and control group

Teaching Method	Mean	Std. error	95% Confidence Interval	
			Lower Bound	Upper Bound
CPA	3.91[a]	.09	3.74	4.08
Conventional	3.61[a]	.09	3.43	3.78

Covariates appearing in the model are evaluated at the following values: pre-test mean = 3.35

This finding is supported by the previous studies on student attitudes towards Geometry, which indicate that teaching approaches in the teaching and learning process affect students' attitudes towards the learning achievement (Hussein 2010; Pilli & Aksu 2013; Yang & Tsai 2010). In this study, the teaching approach that contributes to the improvement of student attitude scores on Geometry is the use of CPA, while in Hussein's (2010) study, the use of software facilities as an approach can also develop an appropriate learning environment to overcome constraints in students' learning and improve students' attitudes in Geometric class. This suggests that the appropriate approach strategy will help to improve student attitudes towards learning (Baharuddin & Hassan, nd). The finding of Yang and Tsai (2010) study also support this finding, which showed that there was a positive impact on student attitudes when appropriate approaches were used in student learning process. This shows that various efforts need to be done to improve students 'attitudes toward learning Geometry which will encourage and influence students' achievement in learning (A Rahman 2000; Farooq & Shah 2008; Fazilahwati@fazilah & Suhailee 2005; Lawsha & Hussain 2011). This finding is also supported by Donaldson and Zager's (2010) study, which showed that students not only showed improvement in understanding but also a positive improvement in attitudes towards their learning when experiencing CPA approach in the teaching and learning process.

This clearly demonstrates that the selection of appropriate approaches such as the CPA method in the teaching and learning process can improve the attitude of students to be more positive towards learning.

CONCLUSION

This quasi-experimental study aimed to investigate the effect of the Concrete-Pictorial-Abstract (CPA) teaching method on Malaysian Community College students' attitudes towards Geometry. Findings show that there are significant differences in attitude towards Geometry between the control and experimental group. This shows that the implementation of CPA approach in the teaching and learning of Geometry brings positive effects on students' attitude towards Geometry. This study provides implications for educators regarding to the approach of CPA method in the teaching and learning process, which is relatively quite new in Malaysia but seen to have a positive impact in the neighboring country's education system. Therefore, it is suggested that Geometry educators in Malaysia to integrate CPA teaching methods in their teaching. In addition, the findings of this study can also help curriculum makers in developing and refining new curriculum with appropriate approaches to teaching method, such as the CPA to improve the quality of national education. There is limitation in this study such as it only involved Community College students with a basic and low knowledge of Geometry regardless the gender differences. Thus, in the future, further studies may be conducted on students with good knowledge of Geometry and consider the gender differences to identify the effects and differences of this CPA teaching method based on gender in terms of student achievement and attitude towards Geometry.

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