EFFECTIVENSS OF USING CIRCLE GEOMETRY BOARD STRATEGY IN LEARNING CIRCLE GEOMETRY TOWARDS FORM FOUR STUDENTS' PERFORMANCE

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ABSTRACT

This study aims to determine the effectiveness of Circle Geometry Board (CG-Board) strategy in learning Circle Geometry towards Form Four students' performance. This study also examined students' Van Hiele's level of Geometric Thought. The pre-test and post-test non-equivalent control group quasi-experimental designed was used. The selection of subjects was conducted by cluster probability sampling involving 52 Form Four students at a school in Hilir Perak district. The subjects were divided equally into control and treatment group. A three-week intervention was carried out. The instruments used are prior knowledge test, a set of pre-test and post-test on Circle Geometry and observation checklist. Descriptive analysis was used to describe students' performance in the topic while independent t-test was used to determine the differences between the teaching strategies. The result showed that there was an increase in students' performance in both control and treatment groups. Based on the t-test analysis, the mean score of the treatment group was higher than the mean score of the control group significantly [$t(50) = -19.294$, $p < 0.05$]. The treatment group's students' performance gained significantly higher than the control group. The students' Van Hiele's level of Geometric Thought also showed an increase from visual to abstract thinking level. In conclusion, the effectiveness of using the CG-Board strategy in Circle Geometry has improved the students' performance. The implication of the study shows that CG-Board strategy can be used to improve the effectiveness of teaching and facilitating of Circle Geometry among students.

KEBERKESANAN PENGGUNAAN STRATEGI PAPAN GEOMETRI BULATAN DALAM PEMBELAJARAN GEOMETRI BULATAN TERHADAP PENCAPAIAN PELAJAR TINGKATAN EMPAT

ABSTRAK

Kajian ini bertujuan untuk mengkaji keberkesanan penggunaan strategi papan Geometri Bulatan (Papan-GB) dalam pembelajaran Geometri Bulatan terhadap pencapaian pelajar Tingkatan Empat. Kajian ini juga menguji tahap pemikiran Geometri Van Hiele pelajar. Reka bentuk ujian-pra dan ujian-pasca kumpulan kawalan tidak setara kuasi eksperimen telah digunakan. Pemilihan subjek kajian dilakukan secara pensampelan kebarangkalian rawak kluster yang melibatkan 52 orang pelajar Tingkatan Empat di sebuah sekolah di daerah Hilir Perak. Subjek dibahagikan sama rata kepada kumpulan kawalan dan rawatan. Satu intervensi selama tiga minggu dijalankan. Instrumen yang digunakan adalah ujian pengetahuan sedia ada, satu set ujian-pra dan ujian-pasca bagi Geometri Bulatan dan senarai semak pemerhatian. Analisis deskriptif digunakan untuk menjelaskan pencapaian pelajar dalam topik tersebut manakala pensampelan tidak bersandar ujian-t digunakan untuk menentukan perbezaan di antara strategi pengajaran. Hasil kajian menunjukkan terdapat peningkatan dalam pencapaian pada kedua-dua kumpulan kawalan dan rawatan. Berdasarkan analisis ujian-t, min markah pelajar kumpulan rawatan mengatasi min markah pelajar kumpulan rawatan secara signifikan [$t(50) = -19.294$, $p < 0.05$]. Kumpulan rawatan memperoleh peningkatan pencapaian yang lebih tinggi berbanding kumpulan kawalan secara signifikan. Tahap pemikiran Geometri Van Hiele pelajar juga telah menunjukkan peningkatan dari tahap pemikiran visual ke tahap pemikiran abstrak. Secara kesimpulan, keberkesanan penggunaan strategi Papan-GB dalam Geometri Bulatan telah meningkatkan pencapaian pelajar. Implikasi kajian menunjukkan strategi Papan-GB dapat digunakan untuk meningkatkan keberkesanan pengajaran dan pemudahcaraan Geometri Bulatan dalam kalangan pelajar.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Geometry stands for *geo* which means *earth* and *metria* means measure. Geometry is probably one of the most ancient branches of mathematics that was used to measure land and construct religious and cultural artefacts (Jones, 2002). On the contrary, Coxeter (1973) said that geometry is the most elementary of science that helps man to use the process of intellectual to make prediction about the physical world.

In the field of education, geometry is known as one of pillars of mathematics (Atiyah, 2001) and measurement is used as a tool to calculate and solve problems (Isikal, Koc & Osmanglu, 2010). The National Council of Teachers of Mathematics (NCTM, 2000), emphasized its prominence by stating that "geometry offers an aspect of mathematical thinking that is different from, but connected to, the worlds of

numbers" (p.97). This statement supports that geometry cannot be learned without numbers or measurements.

The mathematical thinking of the students can be reinforced through the teaching and learning process. The teaching and learning of geometry has progressed from transferring theoretical understanding to hands-on learning. The ability to use manipulative helps student to build confidence and understanding of spatial situations. With this specification on geometry in mind, the teaching and learning of Circle Geometry is explored in the sense that the students will be engage in their learning process. Engaging themselves will definitely expand their geometrical thinking and will give impact on their performance and motivation to learn geometry (Sunzuma et al., 2013).

1.2 Research Background

There are many components in geometry. The component of geometry is introduced in the primary school which includes measurements and recognising simple shapes like circle, square, rectangle and square. They are further led to find the perimeter and the area of a given shape. Later in secondary school, they are given introduction to the topic Lines and Angles, Circles, Polygons, Volumes and Areas of Solid Geometry, Bearing, Transformation and Planes and Dimension (Curriculum Development Centre, 2000).

In this research, Circle Geometry is chosen to be explored. In the Malaysian syllabus, it involves measurement of diameter, radius, and chord. After measurement is taught, area and perimeter of a sector is explored. Finally, the concepts of Circle Geometry are introduced (Curriculum Development Centre, 2000). Even though Circle Geometry is introduced subsequently, students still have problems in visualising and solving problems in Circle Geometry (Piggott & Woodham, 2011). Students fail to grasp geometry concept, reasoning and perform problem solving (Battista, 1999; Idris, 2006). Furthermore, students are unable to link more than one concept of Circle Geometry presented in a circle (Tall & Razali, 1993). Based on Idris (2006), the problems faced by the students in learning geometry has lead students to acquire poor performance. Students' performance is related to the method of teaching used (Udeinya & Okabiah, 1991). The method of teaching that is used to teach students, gives either positive or negative feedback from the students (Adunola, 2011).

To motivate students to learn geometry, many innovative geometric tools have been developed. For example, *Geometer's Sketchpad, Geogebra,* and *Cabri.* Many researches have been done using these innovative tools so that they can visualise clearly and they have shown positive learning and achievement (Bhagat & Chang, 2015).

Nevertheless, students' understanding in geometry through interactive tools doesn't show what students perceive in their learning (Burns et al., 2012). Students still need to understand and have some knowledge of the mathematics before they start using the interactive tools to learn a certain concept in mathematics. They still need to understand the mathematics before they interact with the software (Sacristan et al., 2009).

Finally, a review on the studies of Circle Geometry was done. It is found that the researches in Circle Geometry are quite minimal. The recent research that has been done for Circle Geometry was in 2014. It was done by Oladosu. This researcher gets a perspective on students' meaning in learning Circle Geometry. Another research was done by Gweshe (2014) on virtual manipulatives. Gweshe emphasizes that the use of Geogebra have improved the students' performance in Circle Geometry and motivation of Grade 11 was higher. Both researches are done on the students learning attitude and the use of virtual manipulative. Bhagat and Chang (2015), did a research on the same year regarding the use of Geogebra in improving students' performance in Circle Geometry. Though all the research done showed positive result, there were no further research was done on Circle Geometry using a physical manipulative. Besides that, many researches on Van Hiele's Level of Geometric Thought discusses other geometry topics but not on Circle Geometry.

1.3 Problem Statement

Learning Circle Geometry may not be easy, many students are unable to develop their understanding on the concepts learned in Circle Geometry (Özerem, 2012). The inadequacy in understanding geometry may lead students to perform badly in geometry (Idris, 2009).

There are few factors discussed here have indicated to the students' performance on Circle Geometry. The students lack in prior knowledge, have cause difficulty in learning Circle Geometry in Form Four (Adolphus, 2011). The students are not able to visualize the part of the circles and angles in a circle learnt previously (Oladosu, 2014). In the analysis of the answer scheme of Mathematics in Sijil Pelajaran Malaysia (SPM) Paper 2 in the year 2013 and 2014, it is found that the students were able to use the right formula in finding the perimeter and the area of the circles. Nevertheless, students made mistakes in determining the angle that is subtended from the centre of both sectors; students too, had problem of determining the radius of the sectors (Tall & Razali, 1993; Milwaukee Public Schools, 2011; Lembaga Peperiksaan Malaysia, 2013, 2014). This shows that the students' prior knowledge from Form 2 and Form 3 has deterred the students' ability to perform in the Circle Geometry questions.

Misconception in learning geometry has also been identified while Circle Geometry is taught. Misconceptions happens when the students prefer to observe and memorize the geometrical concept (Idris, 2006; Mehdiyev, 2009) and formula (Furqon, 2007; Fariana 2011). The students have minimal understanding in basic geometry vocabulary. Their minimal understanding has made students not to understand the definition (Neel-Romine, Paul & Shafer, 2012) and properties of geometry (Clement & Battista, 1992; Özerem, 2012). When the students do not explore their own understanding then the students are incompetent to visualise and explore the concept of geometrical concept, reasoning and problem-solving skills which has significant relationship with students' achievement (Ferreira & Palhares, 2008; Karaoglan, 2009; Perveen, 2010; Gök & Silay, 2010).

The students are also not creative and logical in solving the problem (Gloria, 2015). The students solely rely on the text book and their teacher for the knowledge. Learning geometry from the text book hinders the students' problem-solving skills and the development of their spatial thinking, analysing and conceptualizing the ideas of geometry (Altabano, 2002). It is found that the inadequacy in resources too, can de-motivate students from learning geometry especially circle and three-dimensional shapes and has caused students' poor performance in the subject (Battista, 1999; Olkun, 2009; Idris, 2009). The students stick to the memorise steps taught by their respective teachers. Memorised steps have caused student not to explore non-routine steps and they tend to avoid re-checking their answers (Sakorn, 2009; Saragih, 2011) as they are uncertain of their working. The students could not create logical argument efficiently using operation in geometry. They tend to provide irrelevant information which is not useful in problem solving (Ndlovu & Mji, 2012). This is because the students have forgotten the Circle Geometry concept learnt in Form Two and Form Three. They are unable to give reason for each statement made to solve a problem (Adolphus, 2011).

The students' learning attitude towards mathematics is linked with the teaching method used by the teachers. The students neither interact with their friends nor the teacher to find out the answer. Conventional teaching method in teaching Circle Geometry has caused students not to explore or discover their own knowledge concretely as they become passive and mere observer (Reed, 1996; Wagner, 2004; Fabiyi, 2017). Teachers too, do not implement on the use of any kind of manipulatives as their teaching tools because of their time constrain in their daily lesson (Joyner, 1990).

To solve the problems faced by the students, a physical manipulative will be introduced in this research. The physical manipulative which is the CG-board strategy is used to aid the students to learn the concept of Circle Geometry. This CG-board will be accompanied by an activity book to facilitate the use of the board. These activities are found in the form of lessons, which, touch five learning objectives that is needed to answer questions of Circle Geometry concept. The activity book is designed using the Van Hiele's phases of learning, helps them to develop their geometric thinking. The Van Hiele's learning phase helps students to be involved in discussion and reflection (Mason, 1998) throughout the lesson. The reflection and discussion done by the students are according to the CG-board strategy that is introduced in the research. By using the activity book and the CG-board, the students are given the opportunity to discover and explore each Circle Geometry concept. Furthermore, the activity book and the CG-board help to inculcate logical and creative thinking as it presents the student the opportunity to solve the problem in their own way (Heddens, 1986; Piccioto, 1998; Sebesta & Martin, 2004).

1.4 Purpose of Research

The purpose of the research is to test the effectiveness of the usage of CG-board and activity book for Circle Geometry on Form Four students' performance. Besides that, the research is done to investigate the students' level in the Van Hiele's Level of Geometry Thought.

1.5 Objectives

The objectives that are needed to be achieved for this research are as below:

i. to develop the CG-board strategy for learning Circle Geometry concept for the Form Four students,

ii. to test the effectiveness of the usage of CG-board strategy based on the Van Hiele's Level of Geometry Thought in the teaching and learning of Circle Geometry concept for Form Four students comparing conventional strategy, and

iii. to test the students' Van Hiele's Level of Geometric Thought before and after the CG-board and activity book is implemented based on the items developed.

1.6 Research Questions

The following are the research questions:

i. What is the difference between the mean scores of the control and treatment group students' performance in Circle Geometry before any intervention is given in learning Circle Geometry?

ii. What is the difference between the mean scores of the control group students' performance after a conventional strategy of learning Circle Geometry is used and the treatment group students' performance in Circle Geometry after the CG-board and activity book is used in learning Circle Geometry?

iii. Are there any significant changes in the mean scores of the control group students' performance before and after the conventional strategy of learning Circle Geometry?

iv. Are there any significant changes in the mean scores of the treatment group students' performance before and after the CG-board strategy is used in learning Circle Geometry?

v. Are there any significant difference in the students' Van Hiele's Level of Geometric Thought before and after CG-board strategy is used in learning Circle Geometry?

1.7 Hypotheses

The hypotheses below are developed according to the research questions.

For the second research question, the null hypothesis is

H_{01}: There is no significant difference between the mean scores of the control group students' performance and the treatment group students' performance in Circle Geometry before any intervention is implemented.

For the third research question, the null hypothesis is

H_{02}: There is no significant difference between the mean scores of the control group students' performance after a conventional strategy of learning Circle Geometry is implemented and the treatment group students' performance in Circle Geometry after the CG-board strategy is used in learning Circle Geometry is implemented.

For the fourth research question, the null hypothesis is

H_{03}: There are no significant changes in the mean scores of the control group students' performance before and after the conventional strategy of learning Circle Geometry is implemented.

For the fifth research question, the null hypothesis is

H_{04}: There are no significant changes in the mean scores of the treatment group students' performance before and after CG-board strategy for Circle Geometry is implemented.

For the sixth research question, the null hypothesis is

H_{05}: There are no any significant difference in the students' Van Hiele's Level of Geometric Thought before and after CG-board strategy is used in learning Circle Geometry.

1.8 Conceptual Framework

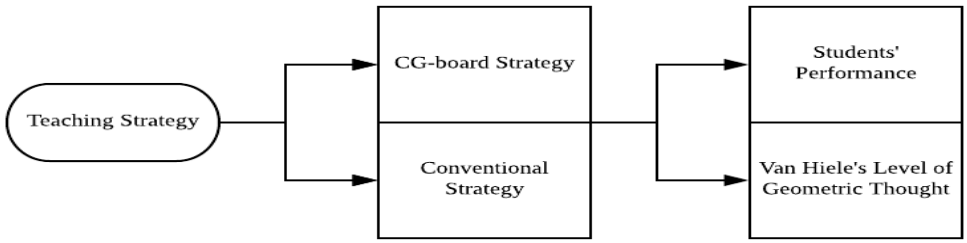

Figure 1.1 Conceptual Framework for Learning Circle Geometry

The conceptual framework begins with identifying the independent variable of the research. In this research, the independent variable is the teaching strategy. For the treatment group the CG-board strategy is used to test the teaching strategy. This stage is suitable as the researcher can integrate the Activity Book and CG-board to develop the Circle Geometry concept. The focus on using the students' prior knowledge to relate the new knowledge receive, help students to develop an understanding. For the control group the conventional teaching strategy is used. Conventional strategy in this research uses the text book (Al-ebous,2016).