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THIS DISSERTATION IS SUBMITTED TO MEET PART OF THE REQUIREMENT FOR MASTER OF EDUCATION (MATHEMATICS) (MASTER BY MIXED MODE)

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ABSTRACT

The purpose of this study was to investigate the effect of integrating the usage of GeoGebra software into the teaching of Circle III topic involving Form Four students. This study employed the quasi experimental nonequivalent control group design, in which the experimental group (consists of 29 students) was taught using the GeoGebra Strategy Teaching (GST) while the control group (consists of 17 students) was taught using the Conventional Strategy Teaching (CST). Instrumentations that were employed included pretest, posttest, and questionnaire on attitude. One way ANCOVA has showed that there was no significant difference between the mean scores of students with GST compared to the CST students, [F (1, 43) = 3.354, $p > .05$]. One sample t-test showed that the experimental group had positive attitudes on the integration of GeoGebra into learning Circle III, [t (28) = 13.32, $p < .05$]. The Pearson product-moment correlation showed that there was a weak but insignificant relationship between students' attitudes and their test performance, [r (29) = .227, $p > .05$]. However, the paired samples t-test showed a significant difference on mean scores between pretest and posttest for the experimental group, [t (28) = 6.992, $p < .05$] which indicated that GST could be utilized in learning Circle III topic.

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PENGGUNAAN PENGINTEGRASIAN PERISIAN GEOGEBRA DALAM PENGAJARAN TOPIK BULATAN III TERHADAP PELAJAR TINGKATAN EMPAT

ABSTRAK

Tujuan kajian ini adalah untuk menguji kesan pengintegrasian perisian *GeoGebra* dalam pengajaran topik Bulatan III yang melibatkan pelajar Tingkatan Empat. Kajian ini menggunakan reka bentuk kumpulan kawalan tak serupa, di mana kumpulan rawatan (29 orang pelajar) diberi *GeoGebra Strategy Teaching (GST)* manakala kumpulan kawalan (17 orang pelajar) diberi *Conventional* Strategy *Teaching (CST)*. Instrumen dipakai adalah termasuk ujian pra, ujian pasca, dan soal selidik sikap. ANCOVA satu hala telah menunjukkan bahawa tiada perbezaan signifikan antara markah min pelajar dengan *GST* dan pelajar dengan *CST*, [F (1, 43) = 3.354, $p > .05$]. Ujian t satu sampel juga menunjukkan pelajar kumpulan rawatan mempunyai sikap positif terhadap perisian *GeoGebra* dalam pembelajaran topik Bulatan III, t (28) = 13.32, $p < .05$. Kolerasi *Pearson* product-moment menunjukkan bahawa terdapat hubungan yang lemah dan tidak signifikan antara sikap pelajar tersebut dengan pencapaian ujian mereka, r (29) = .227, $p > .05$. Bagainmanapun, ujian t sampel berpasangan telah menunjukkan perbezaan signifikan dalam markah min antara ujian pra dan pasca dalam kumpulan rawatan, t (28) = 6.992, $p< .05$ yang menunjukkan *GST* masih mampu diaplikasikan dalam pembelajaran topik Bulatan III.

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TABLE OF CONTENTS

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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CHAPTER 3 METHODOLOGY

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05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi
05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF APPENDICES

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF TABLES

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF FIGURES

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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LIST OF ABBREVIATIONS

CAI	Computer Assisted Instruction
CAS	Computer Algebra System
CDC	Curriculum Development Centre
CST	Conventional Strategy Teaching
DGS	Dynamic Geometry System
EPRD	Education Planning and Research Department
GC	Graphic Calculator
GST	GeoGebra Strategy Teaching
GW	GeoGebra Worksheet
GSP	Geometer's SketchPad
ICT	Information and Communications Technology
MOE	Malaysian Ministry of Education
NCTM	National Council of Teachers of Mathematics
PMR	*Penilaian Menengah Rendah*
SPM	*Sijil Peperiksaan Malaysia*
SAGQ	Students' Attitudes towards GeoGebra software Integrated in Circle III Topic Questionnaire
SSIS	Smart School Integrated Solution

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CHAPTER 1

INTRODUCTION

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The purposes of the research are to determine the effect of GeoGebra software integrated in teaching Circle III topic on Form Four students' performance, students' attitude towards GeoGebra software integrated in learning Circle III topic, and the relationship between their attitude towards GeoGebra software integrated in this topic and their test performance. This chapter discusses about the introduction, statement of the problem, purposes of the study, research questions, hypotheses, conceptual framework, significance of the study, scope and limitations of the study, and definition of terms.

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1.1 Introduction

In teaching and learning of mathematics, the use of technology is not a new thing and even greatly emphasized. Nowadays, some mathematics software have been introduced and widely practiced all over the world such as Geometer's SketchPad, Autograph, Maple, Matlab, Mathematica and so on (Kamariah Abu Bakar, Ahmad Fauzi Mohd Ayub, Rohani Ahmad Tarmizi, 2010a). One of the importance of educational use of technology is to stimulate students' excitement and interest in dry and difficult subject like mathematics (Rohani Ahmad Tarmizi, Ahmad Fauzi Mohd Ayuh, Kamariah Abu Bakar, & Aida Suraya Yunus, 2010).

Malaysian government has showed greatly concerned on technology used in education field where around USD78 million (RM300 million) has been invested in the pilot launching of Smart School Integrated Solution (SSIS) in 87 local schools (The Smart School, 2005). Royati Abdul Saha, Ahmad Fauzi Mohd Ayub, and Rohani Ahmad Tarmizi (2010) have reported that major investment in ICT has been implemented to achieve effective teaching and learning in the classroom in Malaysia. This is because the use of technology is greatly emphasized in Malaysian Integrated Curriculum for Secondary School Mathematics (Rohani Ahamd Tarmizi, Ahmad Fauzi Mohd Ayub, & Kamariah Abu Bakar, 2009). Curriculum Development Centre (CDC), Malaysian Ministry of Education (MOE) also encourage the use of suitable technologies in building concepts, acquiring skills, solving problems, and exploring the field of mathematics and emphasizes the acquisition of mathematical concepts and knowledge rather than merely doing calculation (Ministry of Education, 2004). Moreover, the National Council of Teachers of Mathematics (2000, 2008) has stated

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that technology is an essential tool for learning mathematics in the 21st century and effective teachers should maximize the potential of technology in order to develop students' understanding, stimulate their interest, and increase their proficiency in mathematics.

Noraini Idris (2009) stated that understanding is not simply remembering mathematical concepts or being able to follow procedures as learning currently no longer emphasizes on correctness of the final answer but has shifted to emphasizing process, context, and understanding. Cajilig (2009) has reported that technology could help to improve mathematics learning and one of the ways to enhance learning is by visualization through mathematics software such as GeoGebra. GeoGebra is one of the software which can help students to understand mathematical concepts clearly, in depth, and with purpose, thus enabling them to explore mathematical ideas (Joubert, 2008; Kamariah Abu Bakar et al., 2010a; Hohenwarter, Hohenwarter, Kreis, & Lavicza, 2008).

1.2 Research Background

Nowadays, there are various types of commercial mathematics software nowadays such as Geometer's SketchPad, Derive, Cabri, Matlab, Autograph and others (Royati Abdul Saha et al., 2010). Malaysia government has implemented GSP software which required high cost in teaching Modern Mathematics Form Four since year 2002. According to Roblyer and Doering (2006), there are some software packages are specifically designed to scaffold students as they practice solving complex problems

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such as Geometer's SketchPad which helps students draw objects and investigate their mathematical properties. This is similar with GeoGebra software where students can use it for graph plotting as a strategy to carry out the plan. There is several open source software which are ready to be downloaded freely such as Maxima, Scilab, Axiom, YACAS, FreeMat, SAGE and GeoGebra is one of them (Kamariah Abu Bakar et al., 2010b). GeoGebra is a free-to-use open source dynamic mathematics software (Joubert, 2009). Utilizing GeoGebra as a teaching tool is not a new thing for foreign countries (Hohenwarter et al., 2008; Lu, 2008). However, the use of open source software in teaching and learning mathematics is still new in Malaysia according to Kamariah Abu Bakar et al. (2010a). Therefore, GeoGebra Strategy Teaching (GST) is introduced in this study in order to help students to have better understanding on mathematical concepts in Circle III topic.

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GeoGebra is a free software and does not require a site license (Green & Robinson, 2009). Teachers can download it for teaching and students can download it for learning as well. This is cost-saving if compared to other licensed software which required high expenditure such as Mathematica, Matlab, Maple V, Geometer's Sketchpad, Autograph, and Graphic Calculators (Kamariah Abu Bakar et al., 2010a). The steps to use GeoGebra are simple and direct if compared to other softwares such as Mathematica and Matlab, which requires programming and coding skills rather than exploring mathematical concepts (Garber & Picking, 2010). Moreover, there are GeoGebra teaching and learning materials which are available and ready for download and free of charge (Little, 2009; Green & Robinson, 2009; Sangwin, 2009). GeoGebra software also brings advantages in teaching and learning process as following (Dikovic, 2009):

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(a) GeoGebra stimulates teachers to use and access technology in the visualization of mathematics; investigations in mathematics; interactive mathematics classes on site or at a distance.

(b) GeoGebra helps students to gain better understanding of mathematics where they can manipulate variables easily by simply dragging "free" objects around the plane of drawing or by using sliders.

(c) GeoGebra provides a good opportunity for cooperative learning such as problem solving in small groups or whole class interactive teaching, or individual/group student presentations.

There are three areas in Modern Mathematics of *Sijil Pelajaran Malaysia (SPM)* which are interrelated to each other, that is, number, shape and space, and relationship. Circle III is a topic under the area of shape and space. Under this topic, it has three subtopics: tangents to a circle, properties of angles related to tangents to a circle, and common tangents to circles. According to Kamariah Abu Bakar et al. (2010b), Circle III topic demands imagery and imagination on the relationship between tangents and angles. Harizon Suffian (2005) and Chianson, Kurumeh, and Obida (2010) have reported that students having difficulties in learning circle geometry. As stated in Rohani Ahmad Tarmizi et al. (2010), use of technology can also enhance understanding of abstract mathematical concepts by enhancing their visualization or graphic representation where it shows the relationships between objects and their properties. Coincidentally, the ability of GeoGebra software to build tangent, angles, circles, animation and graphics ease the teaching of Circle III lesson due to its visualization features (Green & Robinson, 2009; Kamariah Abu Bakar et al., 2010b; Lu, 2008). Therefore, Circle III topic is selected in this study to help students

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having better understanding the mathematical concepts with GeoGebra software integrated.

Teaching with computer assisted is very common in foreign countries or Malaysia (Mohd Aris Othman, 2007). Malaysia encourages learning by using computer was obvious with introduction of Smart School Since 1996 (The Smart School, 2005). It indicated that conventional teaching is no longer enough to support students' learning as they are bored and lose interest in lesson with teacher centered teaching. Educational software like GeoGebra with animation, graphic representation, and color text can help to impress and thus deepen their memory on a mathematics concept. Moreover, learning to use learning software in the context of mathematics can be a very rewarding experience, enhance teaching, and not something that would diverts from the focus of the teaching (Rohani Ahmad Tarmizi et al.,2010). Furthermore, Schenkel (2009) had reported that the more positive the attitude about mathematics, the higher the level of achievement was in the student. Therefore, students' attitude towards GeoGebra software integrated in learning Circle III topic is very important and should be noticed in order to maximize the potential of GeoGebra software that can be used to enhance teaching and learning process.

1.3 Statement of the Problem

According to Harizon Suffian (2005), students have difficulties in determining the properties of two tangents, verifying the relationship between the angle formed by the tangent and the chord with the angle in the alternate segment, and solving questions of

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properties related to the common tangent to two circles. They couldn't grab the concept accurately as they hardly imagine the concepts and its application, therefore teaching materials in form of images are used in order to help students to retain and memorize better. Besides that, Chianson et al. (2010) reported that students have problem in grasping and memorize a mathematical concepts in circle geometry as well. Therefore, the topic of Circle III is chosen as it demands imagery and imagination on the relationship between angles and tangents. GeoGebra has many constructive features and is useful in visualizing mathematical concepts (Green & Robinson, 2009; Harizon Suffian, 2005; Kamariah Abu Bakar et al., 2010b; Lu, 2008). Hence, the teaching and learning process of Circle III topic should be enhanced with utilization of mathematics software such as GeoGebra software in enhancing students' imagination and visualization of the relationship between the objects and their properties. It helps students to connect the theory knowledge and its application better.

Chianson et al. (2010) have reported that teaching method would be the issue that caused students hardly memorize or recall a mathematical concept with ease. They have reported that conventional methods of teaching mathematics have not been very successful. Mogari (1999) reported on conventional teaching as follow:

> "[…] a typical teacher takes a piece of chalk and copy of a textbook from which he/she will take example problems and solve for the class on the board. Thereafter, he/she gives pupils a set of problems based on what he/she was doing earlier on the board to solve. Solutions to these problems will then be given in the subsequent lesson before proceeding with a new topic. Most teachers prefer this routine approach because it enables them to complete the prescribed syllabus quicker (p. 101)."

It is shown that one way interaction, teacher-centered, and lecturing without students' participant have caused students bored easily and lost interest in studying mathematics. Therefore technology tools and educational software are used to grab

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students' attention and their interest as well. Besides that, Afshan Ahmed (2009) has reported that one of the ways to engage bored students is teaching with the incorporation of technology. In his report, one of the respondents suggested that using tools and technology can empower teachers in teaching. One importance of technology in teaching and learning is to stimulate students' excitement and interest in dry and difficult subjects like mathematics (Rohani Ahmad Tarmizi et al., 2010). This can be done as GeoGebra has the function to animate an object on screen which make the lesson become interesting (Joubert, 2009). However, Gao (2006) has commented that technology hardly make a difference in teaching and learning if it is used in traditional way as a replacement for teachers and textbooks to impart basic knowledge and skills. Therefore, creativity in connecting mathematical concepts within Circle III topic with technology should be planned in order to achieve and maximize the use of technology. For instance, GeoGebra software which has the dynamic image of mathematical phenomena is used to replace the blackboard and chalk (Zengin, Furkan, & Kutluca, 2012).

Usually, teachers write their notes on blackboard in conventional teaching and give their explanation while students jot down the notes. As a result, students hardly pay full attention while copying the notes. To solve this problem, GeoGebra worksheet is designed and developed to ease the teaching and learning process. This saves students' times from copying the notes and helps students to follow the lesson with their learning pace. Teachers can avoid the hassle of writing on whiteboard at the same times as well. There are a few of learning modules and worksheets developed with technology integrated to enhance students' understanding towards several subjects (Che Adan Yaakub, 2008; Faridah Hanim, 2004; Hasnira Embong, 2005;

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Norazah Nordin, Effandi Zakaria, Nik Rahimah Nik Mohamed, & Mohamed Amin Embi, 2010; Wan Ranizira Razali, 2007). Therefore, a GeoGebra Worksheet (GW) is developed in this study and is used together with GeoGebra software in teaching Circle III topic.

A great concern shown on students' attitude affects their mathematics achievement (Atnafu, 2010; Barkatsas, 2009; Gomez-Chacon & Haines, 2008). Attitude plays a crucial role in learning mathematics (Neale, 1969, Schoenfeld, 1989; Ma & Kishor, 1997). Cretchley, Harman, Ellerton, and Fogarty (1999) have reported that students' attitude must be taken into consideration when assessing the value of technology in the mathematics learning. As the potential opportunities offered by GeoGebra for enhancing teaching and learning mathematics are known, it is important to monitor students' attitude towards GeoGebra as well as it may affect their achievement. Barkatsas (2009) reported that one of the factors that associated with high achievement in mathematics is a positive attitude towards learning mathematics with technology. However, it cannot be concluded that positive attitude will always affect good performance (Atnafu, 2010; Mogari, 1999). Although the study of attitude towards mathematics has been developed over a long time, the study of attitude towards information technology has a shorter history in mathematics education (Gomez-Chacon & Haines, 2008). Therefore, students' attitude towards GeoGebra software integrated in learning Circle III topic is investigated in this study.

In this study, GeoGebra Strategy Teaching is carried out in the experimental group to check its use in teaching Circle III topic among Form Four students. Students'

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attitude towards GeoGebra software integrated in Circle III topic and its relationship with their test performance are investigated as well.

1.4 Objectives of the Study

The objectives of this study are to determine:

(a) the effect of GeoGebra software integrated in teaching Circle III topic on Form Four students,

(b) Form Four students' attitude towards GeoGebra software integrated in learning Circle III topic,

(c) the relationship between Form Four students attitude towards GeoGebra software integrated in learning Circle III topic and their test performance.

1.5 Research Questions

The objectives of this study are achieved by answering the following questions:

(a) Is there any significant difference on mean scores of Form Four student's test performance between Conventional Strategy Teaching (CST) and GeoGebra Strategy Teaching (GST) in learning Circle III topic?

(b) What is Form Four students' attitude towards GeoGebra software integrated in learning Circle III topic?

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(c) Is there any relationship between Form Four students' attitude towards GeoGebra software integrated in learning Circle III topic and their test performance (posttest)?

1.6 Hypotheses

The following null hypotheses are formulated to address objectives (a), (b), and (c).

(a) H_0: There is no significant different on mean scores of Form Four students' test performance between Conventional Strategy Teaching (CST) and GeoGebra Strategy Teaching (GST) in learning Circle III topic.

(b) H_0: There is no significant difference between sample mean and hypothesized mean on Form Four students' attitude towards GeoGebra software integrated in learning Circle III topic.

(c) H_0: There is no relationship between Form Four students' attitude towards GeoGebra software integrated in learning Circle III topic and their test performance.

1.7 Conceptual Framework

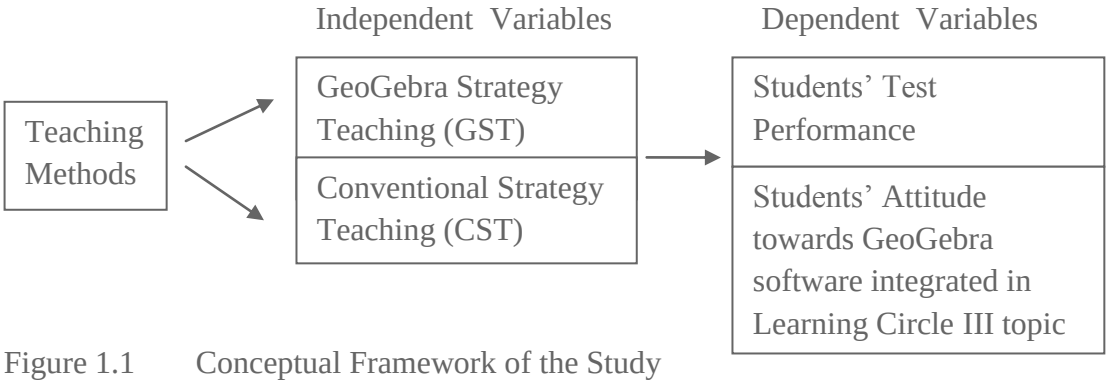

Figure 1.1 Conceptual Framework of the Study

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According to McGaghie, William, Bordage, Georges, and Shea (2001), conceptual framework enables researcher to identify research variables and clarifies relationship among the variables. It helps to connect the research questions and presents the procedural flow of this research. The conceptual framework for this study is depicted in Figure 1.1. This study tests on the effect of GeoGebra software integrated in teaching Circle III topic among Form Four students. Students' attitude towards GeoGebra software integrated in learning Circle III topic is also checked. In addition, the relationship between students' attitude as mentioned above and their test performance is investigated. The types of teaching methods, CST and GST are considered as independent variable. Students' test performance and their attitude towards GeoGebra software integrated in learning Circle III topic are the dependent variables.

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Based on the concepts from the constructivism learning theory and previous researches on using technology in teaching and learning mathematics that provided the background bases for positive effects of the use and integrating of GeoGebra software in mathematics teaching and learning, it is hypothesized that GST will enhance students' test performance in learning Circle III topic and students will have positive attitude towards GeoGebra software integrated in learning Circle III topic. Furthermore, it is hypothesized that there is a relationship between students' attitude towards GeoGebra software integrated in learning Circle III topic and their test' performance (posttest).

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1.8 Significance of the Study

This study can provide beneficial information to related parties on the implementation of GeoGebra software in the teaching and learning of Circle III topic such as CDC to integrate GeoGebra software in mathematics curriculum. Presently, GSP has been integrated in Form Four Mathematics Textbook (Lim, Koo, & Samadi Hashim, 2004). Since GeoGebra has the same potential as GSP, with the added bonus that it is free and open source software, GeoGebra should be studied, developed, and replaced GSP for mathematics teaching and learning. This will be a great cost-saving method for the government from spending huge expenses to renewing the GSP's license.

For teachers, this software provides good guidance in helping students to have better exploration on topics under Shape and Space through color visualization and animation. An attractive presentation can help teachers grab the students' attention. Teachers need only to do pre-drawing preparation and then explain to students in the classroom. This can help teachers to save a lot of time if compared to conventional teaching which requires constant drawing and erasing. Drawings can be drawn and duplicated easily and accurately using GeoGebra, which is impossible to achieve by hand drawing. Responses from students on using GeoGebra are analyzed in this study, and hence to improve the implementation of GeoGebra in the teaching and learning process.

For students, this software can help them visualize abstract mathematical concepts more clearly. Students would be able to understand relationships between Algebra Window and Geometry Window. In Algebra Window, free objects and

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dependent objects are shown after a drawing such as coordinates and equations. Meanwhile, a drawing can be constructed based on the construction toolbars in Geometry Window. Students can check their answers as well through GeoGebra software as it provides measurement of angle, slope, and length of segment and others.

GeoGebra software helps teachers to draw figure which involves angles accurately. It can help to avoid misconceptions that might occur based on inaccurate drawings. In conventional approach, teachers photocopy a page of exercise and cut the questions which they plan to use as exam questions. However, GeoGebra software allows teachers to create their own questions based on students' learning pace and prepare exam questions in a neat way, rather than cut and paste which could be messy. In short, GeoGebra software able to help students understand and visualize a mathematical concepts deeper.

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Furthermore, the questionnaire on students' attitude towards learning Circle III topic with GeoGebra software integrated help teachers to understand better the impact of the technology towards the students. Items in questionnaires reflect students' responses towards the GeoGebra software. It provides teachers information and ideas to maximize the use of software in teaching Circle III topic.

1.9 Scope of the Study

The main aim of the research is to investigate the use of GeoGebra software integrated in teaching Circle III topic on Form Four students. As this research only

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involves Circle III topic, therefore the results cannot represent other topics under Shape and Space. However, the use of GeoGebra can be applied for other topics under Shape and Space.

This study is conducted in one secondary school in Sibu, Sarawak which facilitated with computer laboratory. The samples are two Form Four classes (46 respondents) which have moderate achievement in PMR. Therefore, the results from this study cannot generalize to other district, state or country. However, the results could be used as a reference in conducting GST among Form Four students.

Moreover, the pretest and posttest are designed only to test students' understanding in Circle III topic only. The questionnaires are made only based on the students' attitude towards GeoGebra software integrated in learning Circle III topic.

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1.10 Limitation of the Study

In this study, it is unaffordable for every student to manipulate on desktop with GeoGebra installed because the school has lack of good condition desktop. One of the respondents in Cajilig (2009) has faced the same problem as well where more computer units are still requested for the entire class besides software. Therefore, only the teacher able to manipulate on GeoGebra software in this study meanwhile other students have to pay attention and listen only. However, few students are selected and given chance to manipulate on GeoGebra in finding answer of GeoGebra Worksheet.

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Moreover, the duration of this research study is only about two weeks. This is to avoid disruption of usual class for too long and bring inconvenient to teachers and the school as well. Therefore, the effect of the use of GeoGebra teaching in this study only reflects the condition of two weeks treatment. Besides that, this study presents the use of GeoGebra teaching with only pretest selected as covariate. Therefore, the result limited only to students achievement when pretest is controlled.

1.11 Definitions of Terms

The following are definitions of terms that appear in this study.

(a) GeoGebra Version 3.2

GeoGebra is a dynamic geometry software where geometry constructions can be made with points, vectors, segments, lines, polygons, conic sections, and functions (Joubert, 2009; Wikipedia, 2011). It can be used to make dynamic and interactive material which help students to understand and visualize underlying mathematical concepts.

(b) Conventional Strategy Teaching (CST)

This teaching method focused more on teacher center, chalk and talk in teaching progress. The conventional teaching practices involved direct instruction and lectures, seatwork, and students learn through listening and observation. In this study, teacher is the one who explains and handles the teaching of Circle III topic by writing on blackboard. Conventional Worksheet (CW) is used and no technology device is involved in this teaching.

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(c) GeoGebra Strategy Teaching (GST)

A teaching by using GeoGebra software Version 3.2 to construct and visual mathematical concepts in Circle III topic. Teacher as the conductor to manipulate the slider in GeoGebra view to show the changes on the geometric figures as the radius changes from small to big. Some students are selected and given chance to manipulate on the software in finding answer on Circle III topic. GeoGebra worksheet (GW) is used along with the appliance of software.

(d) Students' Performance

Students' performance in this study is defined by student ability in computations and solving problems, which can normally be measured by written test. It refers to the test scores of Circle III topic that gained by students. Pretest and posttest are compiled of 4 main subjective questions respectively.

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(e) Students' Attitude

Students' attitude reflects their responses on learning Circle III topic with GeoGebra software integrated. It defined as either positive or negative by checking if there is a difference between sample mean and hypothesized mean on Form Four students' attitude towards GeoGebra software integrated in learning Circle III topic.

1.12 Summary

This chapter has briefly introduced the situation of technology use in mathematics education nowadays with problem statements and research objectives written. The

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significance of the study is explained. The next chapter reviewed some literatures on learning theory and impact of educational software in mathematics teaching and learning.

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