

## Effectiveness of Using GeoGebra Software in Teaching Angle in Circle

Syamsiah Hussin, Jasni Mohd Yusoff, Siti Salamah Mustaffa and Dr. Nurazlina Mohamed Mokmin

Department of Mathematics, Science and Computer, Politeknik Balik Pulau, Pinang Nirai, Mukim 6, 11000 Balik Pulau, Penang, Malaysia

**Abstract:** All students of Malaysian Polytechnics have to take Mathematics as one of the compulsory courses in Diploma level. In Mathematical Computing course, Geometry is one of the topics included in the syllabus. However, most students of Balik Pulau Polytechnic have less interest in this topic. Based on the Final Exam Item Analysis, more than 70% of students refused to answer the question related to Geometry. To overcome the situation, researcher try to adopt GeoGebra in teaching and learning session of Geometry, specifically related to angle in circle. The research objective is to determine whether there is major difference between the achievements of two groups of students. This research is a quasi-experimental where one experimental group and one control group undergone a pre-test and post-test about properties of angle in circle. There were 53 randomly selected samples of Semester One students from Diploma of Information Technology (Digital Technology). Data analysis using Statistical Package of Social Science (SPSS) shows that there is insignificant difference between the two groups. It can be concluded that the use of GeoGebra software had a minor impact on students' understanding in Geometry, specifically about Properties of Angles in Circle. However, another similar research can be carried out in a proper and comprehensive setting.

**Key words:** *GeoGebra, teaching and learning method, Mathematics, angle in circle.*

### INTRODUCTION

Several research about GeoGebra aiding the teaching and learning process proved a significant impact on students' achievement in Mathematics. In 2010, Royati Abdul Saha proved that the use of GeoGebra in teaching improved secondary school students' achievement in Kuala Lumpur [1]. Later in 2013, Shaadan conducted a research about the effects of applying GeoGebra in teaching circle to form three students. The result shows that there is substantial difference in the mean score between two groups of samples, where the experimental group gained better score that the control group [2].

Besides, through the research of Dikovic shown that using applet with GeoGebra software had a positive impact on students' understanding in differential calculus [3]. Findings from these researches inspire researcher to study the effectiveness of using GeoGebra in teaching Mathematics to Semester One students in Diploma of Information Technology (Digital Technology) Program.

### Problem Statement

Student's performance in learning certain subject more or less is influenced by their interests in that subject. Based on researcher's observation, most of the students chose not to answer questions related to Geometry during the Final Examination session. The following table further explain the situation.

Table 1: Final Examination's Item Analysis for Mathematical Computing, December 2016 session.

Topic	T1	T2	T3	T4	T5
Average group marks (per 25)	16	13	14	5	20
Total of student answered (from 75 students)	73	19	73	47	74
Minimum score (full marks 25)	3	0	1	0	1
Maximum score (full marks 25)	25	25	25	25	25

The instruction for this course's Final Examination was; students should answer 4 out of 5 questions. Each

**Corresponding Author:** Syamsiah binti Hussin, Lecturer, Department of Mathematics, Science and Computer, Politeknik Balik Pulau, Pinang Nirai, Mukim 6, 11000 Balik Pulau, Penang, Malaysia, +6014 256 6567

question represents topics on Numbering System (T1), Geometry (T2), Complex Number (T3), Calculus (T4) and Matrix (T5). It is learned that from Table 1, only 19 out of 75 students chose T2. It shows that most students were not confident to answer that topic even though they were familiar with Geometry since Secondary School.

From simple surveys conducted in each semester, it was found that most of students had less interest in Geometry. One of the reasons is they did not understand angle of circle. (Please note that researcher does not record these surveys). Perhaps, integrating a digital technology with conventional teaching method can enhance student's performance in Geometry. After attending a training about Geometry, researcher decided to use this in Mathematical Computing class.

### Objective and Scope of Research

The objective of this research is to determine if there is any significant difference between the experimental group and the control group. If the result is positive, perhaps this research can prove that the teaching method with the help of GeoGebra software could enhance students' performance in Geometry.

Scope of pre-test and post-test items are limited to the sub-topic angle in circle. Students found that the concept of angle in circle is quite hard to understand.

## LITERATURE REVIEW

### GeoGebra among other Mathematics Software

GeoGebra is a dynamic mathematical software for all levels of education that brings together geometry, algebra, spreadsheets, graphing, statistics and calculus in one easy-to-use package [4]. GeoGebra is an interactive geometry, algebra, statistics and calculus application, intended for learning and teaching Mathematics and Science from primary school to university level [5].

There are other mathematics apps and resources available online such as CK-12, BuzzMath, PhET Simulations, Geometry Pad, Wolfram Alpha, Brainscape Flashcards, Cabri Express, Desmos and Geometer's Sketchpad. After a thorough review and comparison made, researcher found that only Geometry Pad and Geometer's Sketchpad has similar features that are very close to GeoGebra. Table 2 shows the comparisons made.

The following are the reasons why GeoGebra was the chosen one:

- 1) GeoGebra is accessible online via all medium; personal computers, mobile phones and tablets. As compared to Geometry Pad that is only available on mobile devices [6]. For the researcher, it is convenient to prepare the teaching materials using personal computers (laptop or desktop computers). User can also download the GeoGebra apps for offline use.
- 2) It is an open source software freely available for non-commercial users as compared to Geometer's Sketchpad (GS). A license can be purchase at \$15.00 to \$70.00 per computer to use GS [7].
- 3) As compared to GS, GeoGebra has an up to date resources and support. GeoGebra has the GeoGebra Institute to provide training and knowledge sharing [8]. While the latest available resources for GS dated in the year 2016.
- 4) Researcher has undergoing a training on how to use GeoGebra. Therefore, researcher is comfortable to use this app instead of others, for teaching and research purposes.

Table 2: Comparison between GeoGebra, Geometry Pad and Geometer's Sketchpad.

Software and features	Compared to GeoGebra
<p>1) <u>Geometry Pad</u></p> <ul style="list-style-type: none"> <li>• Mobile educational apps for a modern classroom.</li> <li>• Learn geometry through practice with this dynamic geometry application for Mac, iPad and Android tablets. Geometry Pad allows you create fundamental geometric shapes, explore and change their properties and calculate metrics.</li> <li>• For teachers it allows to add an interactive component to teaching geometry. [6]</li> </ul>	<ul style="list-style-type: none"> <li>• Very similar to GeoGebra</li> <li>• Only accessible via mobile platform, not in personal computers.</li> </ul>
<p>2) <u>Geometer's Sketchpad</u></p> <ul style="list-style-type: none"> <li>• Sketchpad® gives students at all levels—from third grade through college—a tangible, visual way to learn mathematics that increases their engagement, understanding and achievement. (Mc-Graw Hill Education, n.d.)</li> <li>• High school students can use Sketchpad to construct and transform geometric shapes and functions—from linear to trigonometric—promoting deep understanding. [9]</li> </ul>	<ul style="list-style-type: none"> <li>• Similar to GeoGebra.</li> <li>• Not a freeware. Only 20 minutes preview available.</li> </ul>

### Angle of Circle and Geometry

According to Oxford Dictionary, geometry is defined as the branch of Mathematics that deals with measurements and relationships of lines, angles, surfaces and solids [10]. A circle is a plain figure enclosed by a curved line, every point on which is equidistant from a point within, called the centre [11]. Circle seems to be a simple shape, but to measure and determine the angles within the shape require high comprehension and problem-solving skills. Angle is the space between two lines or surfaces that join, measured in degrees [10].

In this research context, Geometry is one of the topics included in Mathematical Computing’s course syllabus and offered in several Malaysia Polytechnics via Information Technology Program (Digital Technology) or the acronym is DDT. It is a compulsory course for the DDT students during the first semester. Geometry is divided into sub-topics which are property of angles in circle, angle of tangent, circumference, area of sector, Pythagoras Theorem along with perimeter, area and volume of solids [12].

However, this research will only focus on angle in circles. In this part, students should be able to describe properties of angles related to circles and cyclic quadrilaterals. It is a pre-requisite knowledge before they can calculate angles related to circles and cyclic quadrilaterals.

### Teaching and Learning in Mathematics with the Aid of Digital Technology

Four main factors that make the digital technology effective in teaching and learning (TnL) activities are digital literacy among teachers, frequency of Internet access, institution’s policy about digital technology in TnL and digital technology infrastructure provided [13].

Adding digital technology element in TnL session has its own challenges. One of them is how to ensure that digital technology makes TnL more efficient. Technology can be meaningful when used in short time period and focus on improving learning outcome. The best use of technology is as an additional method, not as a substitution of the method. Besides, it is important to focus on success story of digital technology related to pedagogy aspect to support the TnL aims [13].

## RESEARCH METHODOLOGY

### Sampling Method

Research involves 53 randomly selected samples from 107 first semester students undergoing DDT Program in Balik Pulau Polytechnic. All of them had registered for Mathematical Computing Course (code DBM1033). DBM1033 is a three (3) credit hours’ course require students to attend class four (4) hours per week to complete the course.

Table 3: Composition of research sample.

Total of sample	Group	Nos. (n)	Percent (%)
53	Experimental	27	51
	Control	26	49

### Research Design

This is a quasi-experimental research, with one experimental group and one control group. Both group undergone the pre-test before TnL session about angle in circle. Then, TnL session about that topic using GeoGebra software carried out to the experimental group. As for the control group, they undergone conventional method of TnL session on the same topic. Finally, both group undertaken the post-test. Both pre-test and post-test consist of five (5) open-ended questions related to properties of angle in circle.

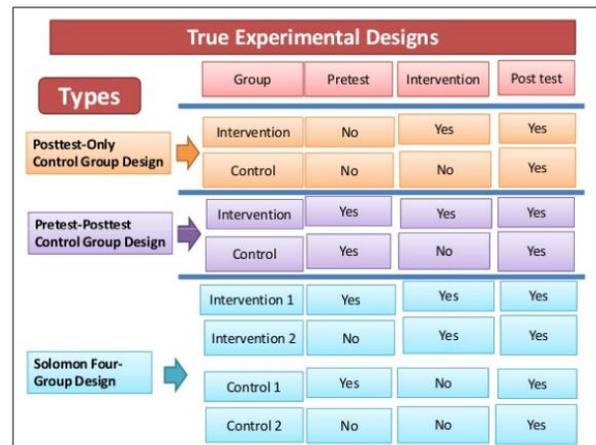


Figure 1: True Experimental Design [14].

Experimental research design is a blueprint of the procedure that enables the researcher to maintain control over all factors that may affect the result of an experiment [15]. In doing this, the researcher attempts to determine or predict what may occur. Researcher selected the Pretest-Posttest Control Group Design because it suits the research’s context.

Table 4: Research Design.

Group	Pre-Test	TnL with GeoGebra	Post-Test
Experimental	O	✓	O
Control	O	x	O

**How the Research Conducted**

The following figures are screenshots from GeoGebra Classic Apps. These were the materials researcher used in the TnL sessions. Figure 2 shows the first property of angle; an angle subtended at the center by an arc is twice any angle subtended at the circumference by the same arc. The dynamic feature of GeoGebra makes it easy to draw a perfect circle and provides numerous examples without drawing another circle. Circle BCD Figure 2(a) is actually the same circle as in Figure 2(b). We just move any point B, C or D to show examples from different angles.

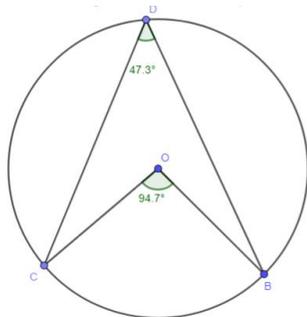


Fig. 2 (a) First property of angle in circle.

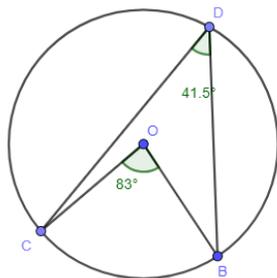


Fig. 2 (b) First property of angle in circle.

Figure 3 shows the second property of angle in circle that is angle subtended by a cord ( $C_1D_1$ ) onto the circumference of a circle is equal.

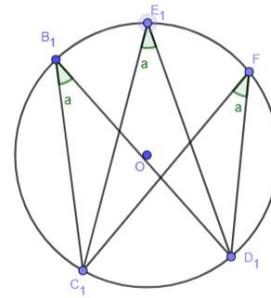


Fig. 3 (a) Second property of angle in circle.

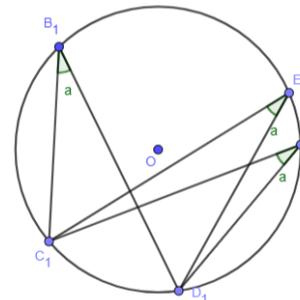


Fig. 3 (b) Second property of angle in circle.

The third property of angle in circle shown in Figure 4 where, angle subtended at the center by arcs of the same length is equal.

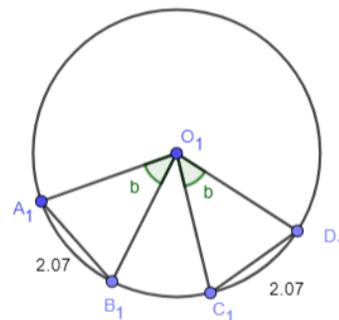


Fig. 4 (a) Third property of angle in circle.

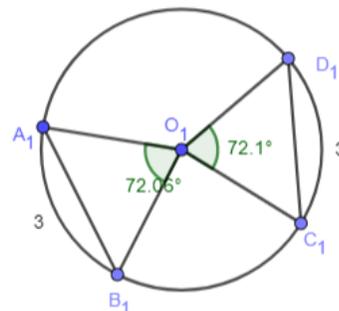


Fig. 4 (b) Third property of angle in circle.

The fourth property of angle in circle says that a diameter subtends a right angle ( $90^\circ$ ) at the circumference, as shown in Figure 5.

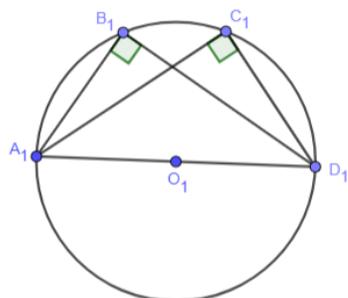


Fig. 5 (a) Fourth property of angle in circle.

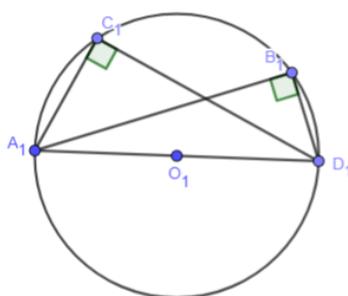


Fig. 5 (b) Fourth property of angle in circle.

### Method of Data Analysis

The findings of the test scores analyzed by using inferential statistics. Through the Statistical Package of Social Science (SPSS) Version 22, independent t-test were applied to find out whether there is a significant difference between the test scores of the two sample groups.

### RESULTS AND DISCUSSION

The results of analysis are as follows.

Table 5: T-test results on the differences between pre-test and post-test scores.

		<b>GROUP1</b>	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	0.367	
	Sig.	0.547	

t-test for Equality of Means	t	-0.806	-0.809
	df	51.000	49.478
	Sig. (2-tailed)	0.424	0.422
	Mean Difference	-6.453	-6.453
	Std. Error Difference	8.006	7.974
95% Confidence Interval of the Difference	Lower	-22.526	-22.473
	Upper	9.620	9.567

Table 5 shows that there is no significant difference between pre-test and post-test score for each group ( $t(51) = -0.806, p = 0.424 > 0.020$ ).

Table 6: Mean score for both groups.

		N	Mean	Std. Deviation	Std. Error Mean
GROUP1	Control Group	26	<b>35.770</b>	25.795	5.059
	Experimental Group	27	<b>42.220</b>	32.026	6.163

Although the result (Table 5) is not significant, learning gain of the experimental group is better than the control group. It shows from the mean score of the experimental group that is 42.22 compared to the control groups mean score, which is 35.77 (Table 6).

### CONCLUSION AND RECOMMENDATIONS

Based on the findings, it proved that there is no significant difference between the two groups of samples. The conclusion is, the use of GeoGebra software had a minor impact on students' understanding in Geometry, specifically about Properties of Angles in Circle.

The following factors probably affects the research result.

- 1) The use of GeoGebra software during TnL process in the classroom is only a one-way lesson (indicated by a lecturer) and does not involved the use of it with students.
- 2) Teaching session using GeoGebra software is only in a short period and students do not have the opportunity to explore the interactive aspects of using this software during the learning process.
- 3) Items used in pre-test and post-tests are too narrow as they are related to properties of angle in circle only.

Hence, further study can be carry out on the same purpose but with a broader scope. Perhaps, with more comprehensive test items. Researcher is still interested to use GeoGebra software in the TnL process in the future; as there are, other aspects that should be explore while using this GeoGebra software.

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