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The Effect of Using GeoGebra in Geometric Construction of Grade 7 Students

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Abstract: ***The objectives of this action analytical research were to examine the usage of the mathematical educational software "Geobebra" and to observe its impact on students' math achievements in understanding some geometric properties and drawing convex and concave polygons such as triangles and quadrilaterals in grade seven in the elementary level. The researcher did not aim other classes and other levels to leave the door open for other researches to study the impact of using GeoGebra on students' geometric construction not only in 2D geometry but also in 3D space geometry in the secondary level. The study was implemented in two grade seven sections (A and B) with ten students in every section, and was consisted of an experimental group (section A) and a control group (section B) targeting the benefit of using information and communication technology (ICT) through the dynamic software GeoGebra to better understand drawing geometric polygons such as equilateral and isosceles triangles. The study utilized a one phase quantitative design. The instruments employed for this study were a pre-test that was distributed to students in both sections A and B to test their prerequisites about triangles and quadrilaterals after which a post-test was distributed to the same students to assess the effect of GeoGebra on improving students' geometric understanding and construction, and finally a 5 point-likert scale survey of standardized items that was distributed to the experimental group students to capture their thoughts toward using the GeoGebra software and how far it was helpful for a better understanding of the subject material in the classrooms. The statistics used for the data collected concerning the study were descriptive inferential statistics using the mean and the standard deviation, in addition to the frequency and the percent to better understand the features of the research as well as the paired-samples t-test. According to the results of the study the researcher concluded that the GeoGebra software has a positive effect on students' geometric understanding and construction in grade seven in drawing polygons and quadrilaterals, and understanding diverse properties because of the software practicality by translating theories into clear images and by allowing students to reposition these images for a better understanding of proper geometric constructions and properties of diverse triangles and quadrilaterals.***

Keywords: GeoGebra, control group, experimental group, geometric understanding, geometric construction, concave and convex polygons

1. Introduction

1.1 Background of the study

Mathematics is one of the most important subjects for students to learn in the schools, so their mathematical performance is critical in determining their scientific pathways and future careers (Barrow & Woods, 1987).Mathematics starts to become a little more abstract for students in the middle schools(Okafior & Anaduaka , 2013)withthemes as in geometry which lead to difficulties in understanding resulting in low motivation, misconceptions and poor math abilities(Fahlberg-Stojanovska, 2009). Learners should know and distinguish the varieties of geometric shapes and their properties(Mammana, 1998) though through traditional education, as in classic teaching methods, teachers instruct their students to use their imagination when faced with an abstract idea or ambiguous geometric concepts for which many students encounter difficulties and obstacles for diverse reasons as in past math deficits or cognitive disabilities. On the other hand, the curriculum in many nations has neglected teaching geometry for being difficult and for many students unable to picture and examine many geometric concepts in addition to the inability of reasoning geometric problems solving(Idris, 2006). For the past decade, technology have waved the path in front of students for better understanding of some geometric concepts and constructions through many software that could be used in classrooms and help improve students' learning because mathematics in modern education demands for more effective teaching strategies and methods for students better understanding of the subject core content, and because several studies have showed that the usage of technological software like Gegoebra can enhance, motivate and engage students in classroom (Pannen, 2014) and can enforce the philosophy of student-centered learning perspective where classrooms become student oriented (Laborde, 2014).Thus, usage of mathematical educational software such as "Geobebra" and its impact on students' learning and understanding of geometric concepts and construction should be addressed and examined as it might help improving students' performance and even behavior towards mathematics.

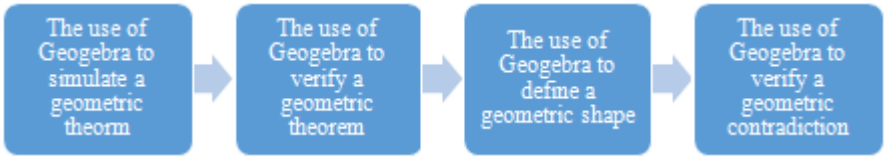
1.2 Up to date research

Using technology nowadays is a very influential tool for students' learning, and the development of using it in classrooms teaching has evolved from one year to another as many mathematical software, like Geogebra, were developed for a better teaching. Many studies concerning the Geogebra software went underway to discover the benefit(s) of using this software which later on revealed that Geogebra is a great tool for teachers' instructional materials, especially in geometry because it helps students view the geometric shapes in different angles (Li, 2007).Some of the issues affecting the learner's outlookof mathematics are teachers' teaching methods and instructional materials (Yilmaz, 2010)thus usage of the technological tools in classrooms is very important because it facilitates students' learning (Eady & Lockyer, 2013). To further examine the effect of GeoGebra on students' understanding, a study was

conducted on a group of 62 students who were divided into two groups:"the experimental group and the control group", where the experimental group contained a set of students who were taught how to use the Geogebra software to solve some statistical problems while the other group solved the same statistical exercises in a classical way without using any math software. The study consisted of four stages, the first stage was to do a pre-achievement test, in order to make sure students in the experimental and control groups were on the same level; the second stage was teaching students in the experimental group some statistical concepts using Geogebra while students in the other group learned statistics without using the software; the third stage wasfor a post achievement test and finally the fourth stage was for students in the experimental group to answer a questionnaire to know their perception on using Geogebra.

2. Theoretical Framework

There are two important aspects for Piaget's constructivism theory: assimilation and accommodation; assimilation is adding and acquiring new information and knowledge that does not contradict with our schema thus learners can deal with this new acquired information according to an existing knowledge, while accommodation is realized when new acquired information contradict with our knowledge and differs from our framework that should be modified for our benefit (Nguyen & Phan, 2015). Geogebra is a dynamic geometry software that is worthy to use for the better of both teachers and learners concerning teaching and learning as it aids the students in acquiring mathematical concepts, rules and growing their abilitiesin problem solving, and leads to a more effective learning environment as students will be able better understand the abstract content that is put in front of them. Constructivism is in a full apply once the learners use the Geogebra dynamic software (Nguyen & Phan, 2015) because this tool supports the constructivist learning perspective as students improve and develop their mental abilities, deeply understand the unit on hand, acquire knowledge that may last for a long time, verify a geometric concept, define a geometric shape, comprehend geometric contradictions and misconceptions from prior classes, relieve students from imagining 2D and/or 3D dimension shapes which is very difficult for many of them, and move on from the passive to the active seat; however, this software takes its toll on teachers as it demands too much experience in its keys and time to properly use it for the benefit of the unit objectives(Cakir, 2008).



Research Questions

1) What is the effect of GeoGebra on student's performance of geometric constructions in grade seven?
2) To what extent does GeoGebra improve students' attitude towards mathematics in grade seven?

Research Hypotheses

$H_0$1: There is no significant relation between GeoGebra and students' performance of geometric constructions in grade seven.
$H_1$1: There is a significant relation between GeoGebra and students' performance of geometric constructions in grade seven.
$H_0$2: There is no significant relation between GeoGebra and students' attitude improvement towards mathematics in grade seven.
$H_1$2: There is a significant relation between GeoGebra and students' attitude improvement towards mathematics in grade seven.

Limitations of the Study: The researcher dealt with two limitations when implementing the study. First, the number of classes in grade seven as there was only two sections which reduced scoping for a wider implementation. Second, the time given to implement the study and extract the results which forbid the researcher from implementing it in other schools

Delimitations of the Study: The staff in the school, where the actual study was implemented, from deputies to the principal helped the researcher separating the two sections in grade seven into one experimental group and one control group which consequently allowed teaching the subject material differently in the designated classes for the benefit of the study.

3. Literature Review

Many schools use the ICT nowadays, such as GeoGebra, as it has become an essential tool (Bist, 2017)that helps facilitate students' learning in different topics and themes such as geometry in mathematics through visuals that help students in geometric constructions and concepts, and that may cause them to modify some of their misconceptions carried from previous classes; though many other educational institutions still follow the classic teaching method in geometry which lower chances of improvements for many students (Heck, 2015).For many math teachers ICT is one of the best tools to prove many geometric concepts and clarify different constructions (Andraphanova, 2015) because tangible tools enhance students' motivation to better understand rigid concepts especially in mathematics through clear observations of images exemplifying the concepts and theories on hand (Gilliland, 2002), and the expansion of the ICT usage has lead the government of Nepal to declare that the use of ICT especially in mathematics enhances students' learning as it provides clear images for cohesive constructions of many geometric polygons according to their curriculum(Bist, 2017). Moreover, Pea (1987) labeled the technological outfits as cognitive outfits for it can assist students' cognitive learning, represent clear geometric shapes and graphs (Sherman, 2016) and it is convenient with students' needs especially in middle schools to properly build their geometric knowledge(Boero, 2006).

4. Methodology

Subject Selection: Students aged twelve in two sections of grade seven were targeted with ten students in each section where the first section represented the experimental group and the second section represented the control group because at this age and in middle schools geometric construction is a basic skill for students to acquire and a needed ability for upcoming classes.

Research Design: This study is classified as a quantitative quasi-experimental designas it analyzed the data collected from pre and post-tests, and a 5 point-likert scale survey in order to determine the effect of using GeoGebra on students'geometric construction in grade seven.

Research Instruments: The pre and post tests andthe survey were validated by a mathematics coordinator and a professor in the higher math education field where the questions were modified a little bit to be more suitable for the designated study after-which the pre-test was distributed to students in both sections, followed by the post-test to the same students and finallythe5 point-likert scale survey of ten standardized items adapted from the Tribhuvan University, Kirtipur, Nepal(Bist, 2017)where each answer was quantified as follows: 1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree and 5 = Strongly agree.

Math Pre-Test

Date: Duration: 45 minutes

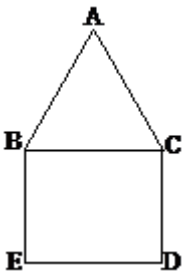
1) (1 point)

Circle the property related to each type of proposed triangles in the table below.

Name	Lengths of sides	Measures of angles
Scalene	All 3 different	All 3 the same
Isosceles	All 3 are the same	2 are the same
Equilateral	All 3 the same	All 3 different
Right	All 3 the same	One is right

2) (1 point)

Complete: in any triangle, the sum of the measures of the three angles is …….



3) (4 points)

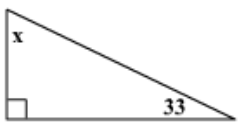
a) Draw a triangle ABC where $BC = 5cm$, $\widehat{ABC} = 45°$ and $\widehat{ACB} = 60°$.
b) Draw a triangle MNP of sides $NP = 5\ cm, MN = 6\ cm$ and $MP = 7\ cm$
c) Draw an isosceles triangle ABC of main vertex A, where AB=AC= 4cm
d) Draw an equilateral triangle DEF of side is 5 cm.

4) (1 point)

In the adjacent figure find the value of x , where x is a measure in degree of the given angle in the figure.

……..

……..



5) (1 point)

Draw a square ABCD with side 4 cm, and then draw a rectangle EFGH with length 4 cm and width 3 cm.

6) (2 points)

Answer by true or false:

1) In a rectangle the area is: $\frac{Length \times Width}{2}$ ……

2) In a rectangle the perimeter is : $2(Length + Width)$……..

3) In a square the area is : $4 \times side$ …….

4) In a square the perimeter is : $side^2$……..

Math post-Test

Date: Duration: 45 minutes

1) (3 points)

a) Draw an equilateral triangle KLM of side 4 cm.
b) Draw an isosceles triangle ABC where $AB = AC = 5\ cm$ and $BC = 4\ cm$.
c) Draw a triangle MNP of sides $NP = 4\ cm, MN = 5\ cm$ and $MP = 6\ cm$.

2) (3 points)

In the adjacent figure, BCDE is a square of area 36 cm^2 and ABC is an equilateral triangle of perimeter 18 cm.

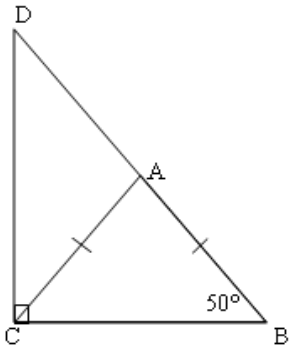
1) Calculate the length of a side of the triangle ABC.

……..……..

2) Calculate the length of a side of ABCD.
……..……..

3) Calculate the perimeter of the polygon ACDEB.
……..
……..

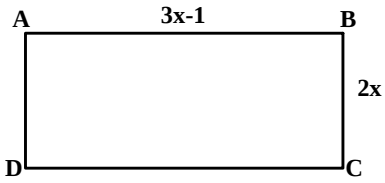
3) (2 points)
By using the adjacent figure, calculate



1) $\widehat{ACB}$; $\widehat{ACD}$ *and* $\widehat{ADC}$. With the suitable justification
……..
……..
……..
……..

2) Deduce the nature of triangle ACD. Justify your answer.
……

4) (2 points)
In the adjacent figure, ABCD is a rectangle, where x represents the length in cm and $x > \frac{1}{3}$



1) What should the value of x be so that ABCD becomes a square?
……
……

2) Suppose that x=1. Calculate the area and the perimeter of ABCD.
……

5 point Likert scale survey items

1) GeoGebra helped me to find new ways to solve problems.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

2) I can think creatively and critically when using GeoGebra.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

3) I did not explore a new geometric concepts using GeoGebra
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

4) GeoGebra helped me to learn basic ideas better.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

5) I would like to learn more geometric concepts through GeoGebra
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

6) I find it difficult to use GeoGebra.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

7) The dynamic platform of geometric construction was interesting.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

8) It was boring to construct new items.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

9) GeoGebra helped me improve myself in constructing geometric shapes meaningfully.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

10) GeoGebra helped me to construct systematically due to the visualization of subsequent steps.
a. Strongly disagree
b. Disagree
c. Neutral
d. Agree
e. Strongly agree

GeoGebra Activities with the Experimental Group:

Activity 1-
Objective: discovering the property of the sum of the anglesin any triangle.
Each student will be asked to draw a triangle using GeoGebra perform the sum of its angles, then they will be asked to manipulate these triangles until they are convinced about the property of the sum of the angles in a triangle. "In a triangle the sum of angles is 180°

Activity 2-
Objective: drawing an isosceles and equilateral triangles.
Students will be asked to draw a triangle with two equal sides using GeoGebra, and the role of the teacher will be guiding the students toward the steps of construction by using the dynamic software GeoGebra.Students will finally realize the construction of the isosceles and equilateral triangles by using the virtual compass embedded in the software.

Activity 3-
Objective: drawing other types of triangles.
Students will be given some measures and lengths to draw different types of triangles, like giving the measure of a side and its adjacent angles, an angle included between two sides and the measure of three sides. In each case students should try drawing these triangles using GeoGebra, they have the freedom to think, explore and navigate through the construction tools in this software.

Activity 4-
Objective: understanding the properties of some remarkable triangles. After the students understand very well how to construct the different types of triangles, they have to understand the properties of some remarkable triangles like the isosceles trianglesof two equal sides and two equal angles, the equilateral triangles of three equal sides and three equal angles, and the right angle triangle. This activity will allow the students to visualize the properties of diverse triangles using GeoGebra, and they will notice for example that the properties of the isosceles and equilateral triangles remain the same in different shapes.

Activity 5-
Objective: Drawing quadrilaterals like squares and rectangles.

Learning Objectives
The researcher set his sights on the following objectives prior to the study:
a) Introducing the concepts of triangles;
b) Drawing triangles like scalene, isosceles, equilateral and right triangles;
c) Using the angle sum property to calculate the measure of an angle inside a triangle;
d) Understanding the relation between the angles and triangles;
e) Drawing quadrilaterals such as squares and rectangles;
f) Calculating the areas and the perimeters of some polygons;

Pre-Test Learning Objectives:
Question 1: to test the prerequisites of students about some types of triangles to have an idea about if they know the basic properties of some polygons.
Question 2: to test if the students are aware of the angle sum property.
Question 3: to check if the students have the suitable skills for drawing triangles using geometric tool.
Question 4: to understand the relation between the measures in degree of angles inside a triangle.
Question 5: to understand the basic concepts of drawing a square and a rectangle.
Question 6: to know the prerequisites of the students about some geometric rules like the areas and perimeters.

Post-Test Learning Objectives
Question 1: to test the students' abilities to draw some types of triangles after learning the topic.
Question 2: to test if the students can find a link between the area and the perimeter and the side of a polygon.
Question 3: to test if the students can use the angle sum property to calculate the measure of angles with the suitable justification then linking the measures of these angles to discover the nature of a certain polygon.
Question 4: to find a certain relation that leads to understanding that a rectangle becomes a square if the length and the width are equal, and then doing some application on calculating the area and the perimeter of a polygon.

Validity Test: Regarding the pre, post-tests and the survey validities, one copy was given to a mathematics teacher with a respectable reputation in the intermediate level and another copy was given to an instructor in the field of mathematics in higher education for any modifications that can enhance the research study prior to formally distribute them to students in grade seven with one scholar week between the implementations of the two tests.

5. Data Analysis

The data collected was analyzed by the Statistical Package for the Social Sciences (SPSS) software version 23.

Table 1: Gender of Respondents in Terms of Frequency and Percentage

	Gender of the participant (Student)		
	Frequency	Percent	Average Age
Male	15	75%	12
Female	5	25%	12
Total	20	100%	

Table 1 shows that there was 15 boys and 5 girls out of the 20 students participating in the study which signifies that

75% of the participants were males and 25% were females with an average age of 12 years.

Table 2: Descriptive Inferential Statistics for the Pre-Test of the Control and Experimental Groups

Tests \ Indicators	Mean	Standard Deviation	Total
Pre-test of the control group	5.9750	2.45077	10
Pre-test of the experimental group	5.8500	2.23669	10

Table2 shows that both the experimental and the control groups have close averages (5.975 over 10 for the control group and 5.85 over 10 for the experimental group) with a difference of only 0.125 which reflects that students in both groups were on the same level or close at the beginning of the research study. In addition the standard deviations of both groups are relatively close with a difference of 0.21408 which indicates that the distance from the each of the grades to the average grade of the control group is almost equal to the distance from the each of the grades to the average grade of the experimental group which signifies two regular series in the field of the study.

Table 3: Descriptive Inferential Statistics for the Post-Test of the Control and Experimental Groups

Tests \ Indicators	Mean	Standard Deviation	Total
Post-test of the control group	4.85	3.07363	10
Post-test of the experimental group	6.95	2.02004	10

Table 3 clearly shows that the average grade of the control group decreased from 5.975 over 10 in the pre-test to 4.85 over 10 in the post-test while the average grade of the experimental group increased from 5.85 over 10 in the pre-test to 6.95 over 10 in the post-test signifying that students' performance of the experimental group ameliorated with the usage of the GeoGebra software.

Table 4: Paired Samples t-Test

	Paired Differences				
	Mean	Standard Deviation	t	df	Sig (2-tailed)
Pair Post-test of the control group- Post-test of the experimental group	2.100	2.78687	-2.383	9	0.041

A paired-samples t-test was conducted to compare grade seven students' mathematics performance in geometric constructions for both control and experimental groups. There was a significant difference in the scores for the control group (M = 4.8500, SD = 3.07363) and the scores for the experimental group (M = 6.9500, SD = 2.02004) conditions $t(9) = -2.383$, $p = 0.041 < 0.05$.

Table 5: Frequencies and percent of students' attitudes forusage of GeoGebra in geometric construction

Frequencies and percent of students' attitudes forusage of GeoGebra in geometric construction					
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
GeoGebra helped me to find new ways to solve problems.	1 (10%)	1 (10%)	1 (10%)	1 (10%)	6 (60%)
I can think creatively and critically when using GeoGebra.	0 (0%)	0 (0%)	0 (0%)	4 (40%)	6 (60%)
I did not explore new geometric concepts using GeoGebra.	5 (50%)	2 (20%)	1 (10%)	2 (20%)	0 (0%)
GeoGebra helped me to learn basic ideas better.	1 (10%)	0 (0%)	3 (30%)	4 (40%)	2 (20%)
I would like to learn more geometric concepts through GeoGebra.	0 (0%)	0 (0%)	0 (0%)	5 (50%)	5 (50%)
I find it difficult to use GeoGebra.	1 (10%)	5 (50%)	3 (30%)	1 (10%)	0 (0%)
The dynamic platform of geometric construction was interesting.	0 (0%)	0 (0%)	0 (0%)	5 (50%)	5 (50%)
It was boring to construct new items.	0 (0%)	0 (0%)	0 (0%)	5 (50%)	5 (50%)
GeoGebra helped me improve myself in constructing geometric shapes meaningfully.	3 (30%)	3 (30%)	0 (0%)	1 (10%)	3 (30%)
GeoGebra helped me to construct systematically due to the visualization of subsequent steps.	0 (0%)	0 (0%)	0 (0%)	5 (50%)	5 (50%)

Table 5 shows the frequencies and the percent of each item of the 5 point likert scale survey questionnaire. The first item indicates that 60% of students of the sample strongly agree with the fact that GeoGebra helped them find new ways to solve problems. The second item shows that all students agree (respectively strongly agree) with being able to think creatively and critically when using GeoGebra. The third items points out that 70% of students disagree (respectively strongly disagree) with not exploring new geometric concepts using GeoGebra. The fourth item states that 60% of students agree (respectively strongly agree) with GeoGebra helping them learn basic ideas better. The fifth item shows the strength of GeoGebra as 100% of students of the sample are willing to learn more geometric concepts through it. The sixth item indicates that 60% of students do not find GeoGebra hard to use. The seventh item shows that geometric construction is more interesting to all students of the sample with the usage of GeoGebra. The eighth item support the result of the seventh item as 100% of students of the sample stated that geometric construction was boring prior to GeoGebra usage. The ninth item shows that GeoGebra helped improving 40% of students of the sample in constructing geometric shapes. The tenth item revealed that all students of the sample were able to construct geometric shapes systematically due to the visualization of GeoGebra.

6. Findings

- The research study was designed by categorizing students into two groups "the experimental and the control groups", applying a pre-test to students in both group to test if they were on the same level, using the GeoGebra software in the experimental group, doing a post-test for students in both

groups to compare with the pre-test and then finally distributing a survey for students in the experimental group to capture their attitude toward GeoGebra. At the end of this analytical research, the researcher found out that the average grade of the experimental group (6.95 over 10) was better than that of the control group (4.85 over 10). In addition, only one student in the experimental group failed the post-test while five students in the control group failed the same exam which signifies that students who used GeoGebra acquired better understanding of the geometric concepts.

- By comparing grades in the experimental and control groups the researcher found that one student in the experimental group achieved a full mark (10 over 10) while no student in the control group achieved the same grade. In addition, students' grades in the experimental group were much better than those in the control group which reflects the positive influence of GeoGebra on grade seven students' mathematical performance in the geometric construction. The research findings conforms with other researchers' findings as a previous similar study showed that the average grade of students in the experimental group was 29.48 over 40 compared to an average grade of 20.25 over 40 for students in the control group.

- GeoGebra allows students to understand the sum of the angles in a triangle, how a rectangle can become a square, a rhombus a parallelogram or a trapezoid through clear visualization without even using their imagination for any possible misconceptions. According to the research findings, all students of the sample indicated that GeoGebra help them in geometric construction due to its visualization. This result comes hand on hand with other researches' results as 96.15% of students in another study admitted that GeoGebra in geometric construction due to the visualization of subsequent steps(Bist, 2017).

According to the research findings through the 5 point likert scale survey questionnaire, the majority of students who used GeoGebra in geometric construction for only 5 consecutive sessions had a positive attitude toward the software and agreed on the effective usage of the dynamic software. Comparing the research results with a study done by Puskar Raj Bist in 2017 on the use of GeoGebra in geometric construction, 100% of students in the experimental group of this study agreed that GeoGebra let them to think creatively and critically while 88.6% of students in Puskar's study thought the same, 70% of students in the experimental group of this study disagreed that GeoGebra did not let them to explore anything new while 84.6% of students in Puskar's study thought the same, 60% of students in the experimental group of this study agreed that GeoGebra helped them to learn basic ideas better while 100% of students in Puskar's study agreed on this point, 70% of students in the experimental group of this study agreed that GeoGebra helped them to find new ways to solve math problems while 75% of students in Puskar's study indicated the same thing.

7. Conclusion and Recommendation

The research study shows that GeoGebra has a positive effect on the student's comprehension in drawing polygons as triangles, parallelogram, rhombus and others, and in the geometric concepts by translating theories to practices because of the software's flexibility which allows them dragging and repositioning figures until they reach the right construction of the figure in hand. In addition this the researcher can conclude that using GeoGebra enforces the constructivism learning perspective through assimilation and accommodation because it allows students building their own knowledge, adding new information and even modify cognitive schemas for a better analysis and application through clear visualizations and with a lesser pressure which aids slow learners and those with math specific deficits like short working memory. Finally, according to the 5 point likert scale survey questionnaire and the grades of the post-test exam, the researcher conclude that using GeoGebra positively influences students' attitude toward mathematics and enhances their mathematical performance. The researcher highly recommends using this dynamic software in schools and consider it as a must tool for diverse mathematical themes such as geometric constructions not only in classes of grade seven but also in all classes and levels as GeoGebra might be an essential tool helping students in 2D geometry and 3D space geometry where secondary students are forced to imagine figures in their minds which hinders many students mathematical performance in geometry for their inability to imaging proper 3D shapes.

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