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Improving Mathematics Achievement and Attitude of the Grade 10 Students Using Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS)

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Abstract: **It has become a fact that fluency and competency in utilizing the advancement of technology, specifically the computer and the internet is one way that could help in facilitating learning in mathematics. This study investigated the effects of Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) in teaching Mathematics. This was conducted in Zamboanga del Sur National High School (ZSNHS) during the third grading period of the school year 2015-2016. The study compared the achievement and attitude towards Mathematics between those students taught with DGS and CAS and those students who were taught without DGS and CAS. A quasi-experimental pretest-posttest control group design was used with two groups which was matched according to their mathematical level. An achievement test was developed and administered to assess the students' achievement in Mathematics. Aiken's attitude scale was also used to assess the students' attitude towards Mathematics. The data were treated with One-Way Analysis of Covariance (ANCOVA) and t-test at 0.05 level of significance. The study revealed a significant difference between the mathematics achievement between students taught with DGS and CAS and those who were taught without it. The integration of DGS and CAS in Mathematics lessons leads to better academic achievement result compared with that of the conventional method of teaching. Moreover, there was no significant difference on the attitude level of the students between the two groups.**

Keywords: **quasi-experimental, computer-assisted instruction, achievement, attitude.**

1. INTRODUCTION

The main aim of teaching mathematics in schools is to develop scientific attitude towards Mathematics. The reasoning in mathematics possesses a number of characteristics, namely; characteristics of accuracy, verification of results, certainty of results, similarity to reasoning in life and originality (Ramani, et.al, 2012). All these characteristics automatically become a part and parcel of a child when the student learns mathematics. This is why Plato considers knowledge of mathematics to be prerequisite of citizenship.

In traditional classroom-based mathematics class, much of the learning comes from reading the selected particular textbook, listening to teacher's lectures and taking notes regularly. In effect, students become more lenient on visual features on the board, such as the fact that angles look the same even if they cannot be shown to be so by reasoning logically from theorems and definitions. This plain and laid-back characteristic gives out a boring impression to the students while the fast and interactive trend of the computer technology locks in students' interest which makes it a brilliant teaching tool that could be used in teaching mathematics.

Nowadays, it has become a fact that fluency and competency in utilizing the advancement of technology, specifically, the computer and the internet is one way that could help in facilitating learning. It is undeniable that the technology provides an effective motivation to students. Several studies have shown that students who used computer-based learning practice find mathematics more enjoyable. They like the flexible features provided by the computer practice, spend long hours at a computer to complete a task, and enjoy testing out new ideas on the computer. They are no longer passive recipients of information; they are actively involved in knowledge construction. Thus the computer's computational functionality is being used to support those processes rather than to use it as a vehicle in presenting information only. This concept is supported by Keong, Horani and Daniel (2005) who stressed that the use of ICT in teaching mathematics could make the learning process more effective, and could enhance the students' capabilities in understanding basic mathematics concepts.

Jonassen (2000) asserted that Constructivist educators strive to create environments where learners are required to examine thinking and learning processes; collect, record, and analyze data; formulate and test hypotheses; reflect on previous understandings; and construct their own meaning. The constructivist sense of "active" learning is not listening and then reflecting the correct view of reality, but rather participating in and interacting with the surrounding environment in order to create a personal view of the world. Constructivists engage the learners so that the knowledge they construct is not inert, but rather usable in new and different situations. Some interesting types of these environments are the computer simulation and modeling using Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS). This is supported by the "Learning by Doing" of John Dewey which affirmed that students should take part in their own learning because they perform better if they interact and experience the environment.

Computers and the internet provide new methods of delivering instruction so students will have choices of when, where, and how they learn math. Undeniably, traditional teaching techniques and practices in mathematics have to keep up with the computer technology so as to conveniently sustain students' interest and efficiently facilitate students learning. Traditional teaching and practices in Mathematics is still dominant in Zamboanga del Sur National High School. Although a lot of trainings and seminars on ICT teaching approaches have been conducted already in preparation for the K-12 programs, only a few number of teachers had been practicing and utilizing the Computer-Assisted Instructions like using Computer Algebra Systems (CAS) and Dynamic Geometry Software (DGS).

For the Grade 10 math class, students find it difficult why the measure of the inscribed angle in a circle is always one-half the measure of the intercepted arc. They also have difficulties in identifying the relationships of the segments formed by secants and tangents inside and outside the circle. They also find it hard to solve problems involving circumferences and areas pertaining to circles and sector of circles, which are actually part of the least-learned competencies in the NAT. High school students find these hard to understand and master these concepts. This poses a challenge to the teachers on how to effectively teach the subject. For the past years, the Mean Percentage Score (MPS) and National Achievement Test (NAT) results of the Zambo. Sur National High School clearly shows that the students of the school stand below average in Mathematics. Supposedly, schools are expected to obtain at least 75% ratings and school obtained 49.76% MPS only of the school year 2014-2015.

The nature of the classroom lesson development could be one of the reasons of the change of students' behavior towards mathematics. Generally, our basic education formation in school was done mostly through lecture mode rather than the use of activities that could encourage the students' participation and involvement. The researcher believes that a change of this trend is needed to answer the issue. If the students have a positive attitude towards learning mathematics, it is probably easier for them to understand mathematical concepts which could help them boost their confidence as they work on mathematical operations.

At the end of the study, the researcher anticipated that the integration of the computer-assisted setting in the learning situation can contribute a big change to both the teacher's view of teaching the subject and that the students' interest to the computer will be utilized and optimized in the classroom situation. Hence this study was conducted to investigate the effects of using Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) on the achievement and attitude of students in mathematics.

Research Questions:

A number of researchers think that computer-assisted instruction has great potential for improving developmental education. Others insist, however, that students need personal interaction with their teacher and classmates. Do computer-assisted instructions enhance the learning of Grade 10 mathematics or is traditional instruction more effective for these students?

This study investigated the effects of using Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) on the achievement and attitude of Grade 10 Robin students at Zamboanga del Sur National High School.

Specifically, this study sought answers to the following problems:

1. How do the achievements in Mathematics compare between those students who will be taught with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) and those students who will be taught without Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS)?

2. How do the attitudes of students towards Mathematics compare between those students who will be taught with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) and those students who will be taught without Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS)?

Scope and Limitation:

This study was delimited to investigate the effects of using Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) on the mathematics achievement and attitude of students toward Mathematics. This was conducted in Zamboanga del Sur National High School (ZSNHS), Sta. Maria District, Pagadian City. The study considered the intact section of Grade 10 Robin during the third grading period of S.Y. 2016 – 2017. The whole class was divided into two groups which comprised the experimental and control group.

The geometry concepts of circles were the focus of the study, particularly for the third grading period of the K-12 Grade 10 Math. The topics were the definition of circles, the parts of circles involving arcs, chords and angles, tangents and secants of circles, the different equations of circle, transforming its equations and problems involving circles. The lessons in experimental group were integrated with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) while control group was handled traditionally using conventional methods of instructions. Both the experimental and control group followed the lesson contents of the Grade 10 Math Learning Guide.

One of the research instruments used in the study was the pretest-posttest achievement test prepared by the researcher. The 30-item researcher made test was validated by the panel of experts and its reliability was tested and tried out by one of the grade 10 sections of the Basic Education Curriculum (BEC) of Zamboanga del Sur National High School. The second instrument was the adopted Aiken attitude scale.

There was no analysis on the socio-economic variables of the students who participated in the study. The reasons behind the students' attitudes towards mathematics were not also examined. The analyses were focused on the comparison of the test scores and the attitudes between the experimental group and the control group.

Significance of the Study:

The result of this study would provide information and insights about the integration of modeling and simulations in the classroom using a Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS), as a significant development in education process. Thus, the study would have meaningful and significant value to the students, parents, school administrators, teachers and DepEd officials.

The students who are ultimate beneficiaries of this study could enhance their content knowledge in mathematics while simultaneously developing their information technology skills through meaningful and purposive activities. In this way, students would be able to conceptualize the abstract ideas of Mathematics lessons using this environment. Hence, students' academic achievement would be enhanced.

The teachers would be encouraged to maximize the use of computer-based instructions to improve mathematics performance of the students. Through the process of integration of the DGS and CAS, the teachers could get fast feedback on what the students learn and what lessons need an immediate enrichment discussion. This integration could develop the skills of the teachers to utilize effectively the available information technology equipment in school. Teachers' ability on resourcefulness could be enhanced also for the DGS and CAS have infinite downloadable instructions from the web domain. Various forums of educators in the website can be accessed also for the discussion of the learning development for the effectiveness of the integration of the software.

The Math Education Program would benefit this alternative teaching strategy to improve the mathematics performance of students. This mediation could be an answer to the needs of advancement of the mathematics education system for the students simultaneously developing the computer literacy skills which is the primary need of the learners to compete for this computer age world.

The school administrators would also benefit from this study as they would be provided with vital information on what particular strategies are to be utilized as means of maximizing participation from students. The findings would further give them necessary data on what particular seminar and trainings they would allocate more budgets to develop and advance teachers' competence in utilizing the information technology equipment which in turn would address the countless needs of the students.

The DepEd officials would also benefit since this study may serve as valuable guide that would give them essential information to determine the future direction of the schools particularly on designing and planning seminars and trainings to hone the teachers' competence in utilizing the different strategies especially in using the computer as an instructional aid.

2. REVIEW OF RELATED LITERATURE

In the pre-technology education context, the teacher is the sender or the source, the educational material is the information or message, and the student is the receiver of the information. In terms of the delivery medium, the educator can deliver the message via the "chalk-and- talk" method and overhead projector (OHP) transparencies. This directed instruction model has its foundations embedded in the behavioral learning perspective (Skinner, 1938) and it is a popular technique, which has been used for decades as an educational strategy in all institutions of learning (Damodharan 2007).

Lectures are probably the best teaching method in many circumstances and for many students, especially for communicating conceptual knowledge, and where there is a significant knowledge gap between lecturer and audience (Charlton 2006). This is widely used in the country throughout the formative years to graduate courses. As observed in the field of teaching, the advantages of the lecture approach are that it provides a way to communicate a large amount of information to many listeners, maximizes teacher control and is non-threatening to students.

The disadvantages are that lecturing minimizes feedback from students, assumes an unrealistic level of student understanding and comprehension, and often disengages students from the learning process causing information to be quickly forgotten. Basically, the teacher controls the instructional process, the content is delivered to the entire class and the teacher tends to emphasize factual knowledge. In other words, the teacher delivers the lecture content and the students listen to the lecture. Thus, the learning mode tends to be passive and the learners play little part in their learning process.

Today, educators realize that computer literacy is an important part of a student's education. Integrating technology into a course curriculum when appropriate is proving to be valuable for enhancing and extending the learning experience for faculty and students. Wilson (2009) posited that the advancement of the technology along with the change of type of learner requires fluency and competency with computers and the internet. This has been the bottom line why several studies were conducted not just to investigate the effects of technology but all the other Computer-Assisted Instructions (CAI), Computer-Based Learning (CBL) and Virtual Learning Environment (VLE) to the academic achievement and of attitudes of the students.

In the constructivist's learning process, students seem to have difficulties because they construct ideas from the interaction with the physical world which are not consistent with scientifically accepted ideas (Baser and Durmus, 2010). They often hold misconceptions be they historical, mathematical, grammatical, or scientific. In mathematics, computer simulations (one of the CAI tools) have been investigated as means to help students confront and correct these misconceptions, which often involve essential learning concepts (Strangman, Hall 2009). The constructivists Dewey, Piaget, Vygotsky and Bruner projected that learners could learn actively and construct new knowledge based on their prior knowledge.

Mehanovic (2008) posited that generative learning systems and knowledge construction environments are designed to form partnerships with learners/users, to distribute the cognitive load and responsibility to the part of the learning systems that performs the best. These systems include the Computer Algebra Systems (CAS) and Dynamic Geometry Software (DGS) which assist the learning process in the different areas in mathematics with computer simulations. Computer modeling and simulations are playing an important role in science and mathematics education. Simulations support conceptual development by allowing students to explore relationships among variables in the models of a system. Simulations can facilitate knowledge integration and a deeper understanding of complex topics, such as genetics, environmental science, and physics (Quellmalz, 2008).

Bill (2003) gave examples on how computer based simulation satisfy Gagne's (1956) 9 levels of learning model. The students gain attention through the use of sound, animation, text and graphics in the simulation. Learners are maximizing the capabilities of these technologies as tools for analyzing the world, accessing information, interpreting and organizing their personal knowledge and representing what they know to others. In this kind of environment, learners derive not only formal understandings from their experience, but deeper insights into the details of the concepts under study. Opportunities are provided for students to vary conditions or parameters, increase or decrease complexity, and manipulate normally abstract concepts in tangible ways.

Moreover, Lunce (2006) claimed that educational simulations have a number of advantages over other instructional methodologies and media. Students often find active participation in simulations to be more interesting, intrinsically motivating and closer to real world experiences than other learning modalities. Simulations have been shown to provide transfer of learning with the result that what is learned facilitates improved performance in real-world settings. Simulations can be very flexible in that both student and instructor can have a high degree of control over simulation variables. It allows students to experience phenomena which could be dangerous, expensive or even impossible to observe in the real world.

Ritland (2005) and Frank (2003) emphasized that concepts must not be given directly to students making them as passive in the learning process. These studies gave the researcher the insight that the concepts must be obtained by the learners in a generative process, that learning is much gained if the students are given with environment such as computer simulations which provides the facilitating structure and tools that enable students to make maximum use of their own intelligence and knowledge.

Lunce (2006) affirmed that there are a number of disadvantages in the use of computer simulations. He further stated that without appropriate coaching, scaffolding, feedback and debriefing, the learner gains little from the discovery learning that simulations facilitate. These suggest that teachers play a significant role in giving such learning process to students and thus required to formulate a well-planned activities using the environment to give the students a good time-framed learning process.

Coraje (2009) investigated the effects of information and communication technology (ICT) integration in addition to RBEC lesson guide as teaching approach in selected topics of Advanced Algebra to student's achievement. It was conducted at Davao City National High School, S.Y. 2008-2009, using 68 fourth year heterogeneously grouped students in quasi-experimental design. A 30-item achievement test in exponential and logarithmic functions was used for pretest and posttest. He used mean, standard deviation and ANCOVA. The quasi-experiment showed an improved students' achievement in selected topics in Advanced Algebra when taught with ICT. However, no significant interaction effect exists between mathematical ability and the two teaching approaches.

The study of Dogan (2011) about using DGS and its effect on eight grade students' achievements for the subjects of triangles was conducted. The study was done in the fall semester of 2009-2010 academic year of University of Selcuk, Konya, Turkey. Two eighth grade classes from a primary school were selected as experiment and control groups. The course contained DGS activities and practices about the stated objectives. The planned and DGS constructed activities which demand effective use of DGS for this grade shared with the students during the learning and teaching process.

Simultaneously, the control group continued their formal teaching and learning procedure. After the two weeks, a post test was applied to the both groups simultaneously. The posttest contained questions about the stated objectives for the eighth grade. Furthermore, one month after the application a recall test was applied to both groups as well. Possible comparisons between the tests and the groups were performed. The results show that dynamic software (DGS) has positive effects on students' learning and achievement. It has also been observed that it improves students' motivation with positive impact.

The CAI also inspired Miranda (2012) who designed and developed a computer-based IM, Multi Mouse Mischief lessons on animals, coral reefs and plants for Science V. The study was conducted in North City Central School of Cagayan de Oro city, S.Y. 2011-2012 and used mean and standard deviation as tools. The validated IM can be used by Grade V teachers and students for active peer learning integrating the computer-based lessons.

To achieve these goals, educators must think how they should improve curriculum and instruction. Teachers and administrators must know how to use the hardware and software to introduce a new kind of learning process. As teachers gain easier access and receive training in the use of the latest technology and as technology resources expand through electronic networking, instruction will be enhanced. Consequently, the students become more active, confident, motivated and would achieve at higher levels.

The review of literature gave the researcher ideas on how Computer-Assisted Instructions (CAI) becomes a good learning assistant tool in teaching Mathematics to enhance and increase active students' engagement in the classroom. This was in respond to the need of the teachers to equip a highly demand skills for the new type of learners. Generally, the reviewed literature and studies emphasized that Mathematics has features which foster learning.

3. METHODOLOGY

Design and Sampling:

This study used quasi-experimental pretest-posttest group design to investigate the effects of teaching using Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) on the achievement and attitude of students in mathematics. This design involved the one (1) out of four (4) Grade 10 Mathematics teaching loads of the researcher in Zambo. Sur National High School, school year 2016- 2017, which was randomly assigned into two intact groups: the experimental group and control group. However, for data analysis, the students were divided and matched based from their mathematical ability level. The first grading Mathematics grades of the students were the basis for matching. The experimental group was taught Mathematics with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) as the teaching approach; while the control group was taught Mathematics in Traditional Teaching methods. The two groups were given the same set of lessons.

Data Collection:

A researcher-made achievement test was administered as pretest and posttest to both groups in order to measure their achievement in particular lessons. An adopted attitude scale from Aiken was also given to measure the attitude level of the students in both groups towards Mathematics.

The conduct of the study started by giving both the experimental and the control group the pretest. The answers of the students were checked and recorded to serve as the covariate of the study. After the administration of the pretest, the same set of lessons were given to both groups which covered the entire module of Circles of Grade 10 Mathematics Learning Module. The Experimental group was taught with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) and the control group was done traditionally. After all topics were covered, the posttest was given to both groups to assess how much the students had learned from the teaching with Computer-Assisted Instruction and from the traditional method. The two groups also answered the mathematics attitude scale to measure their attitude towards mathematics. Unstructured interviews were also conducted to respondents to supplement the necessary insights and ideas developed by the students during the study.

Plan for Data Analysis:

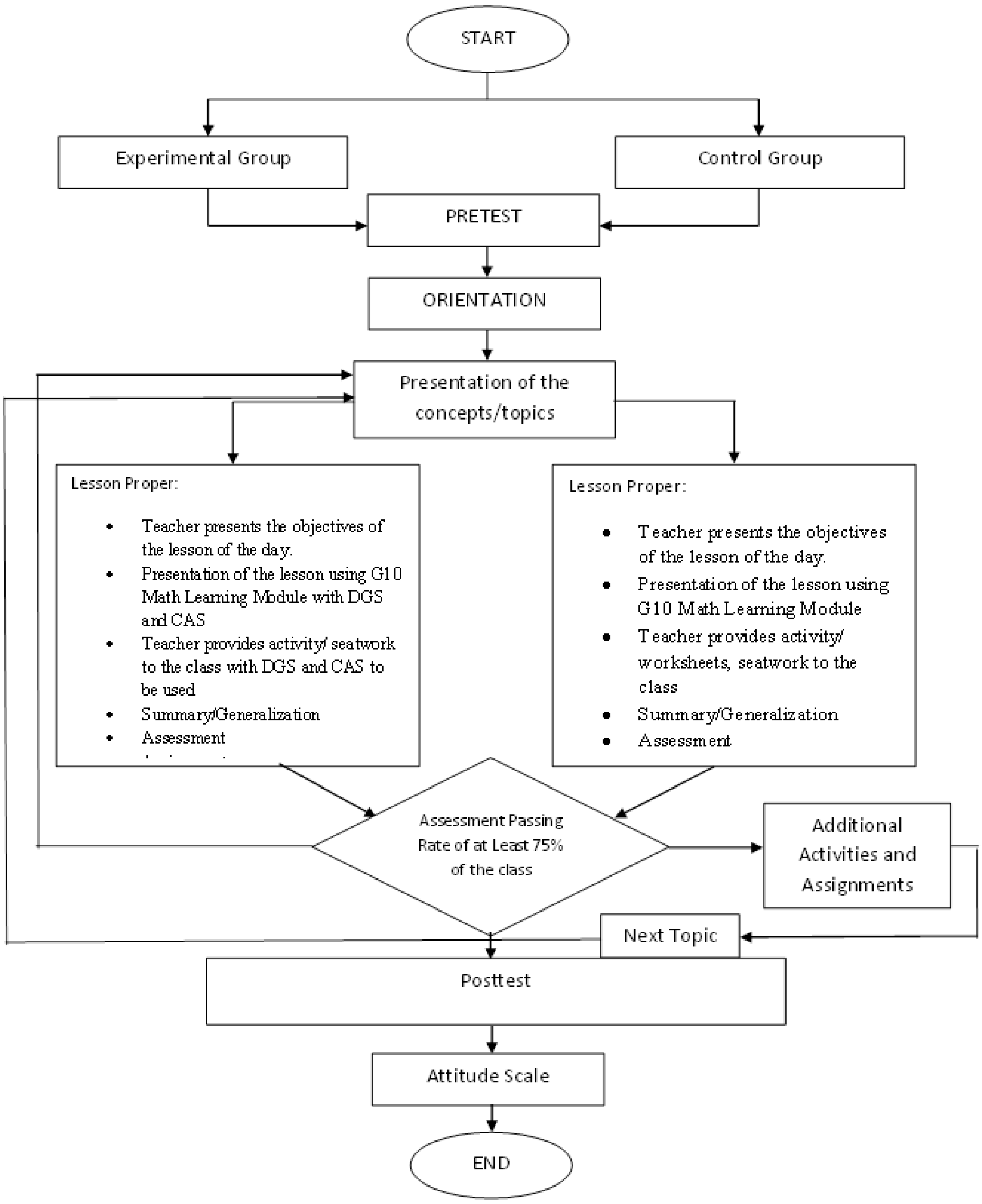
For the analysis and interpretation, the data were tested at 0.05 level of significance. Mean, Standard Deviation and One – way Analysis of Covariance (ANCOVA) were the statistical tools used to examine the significant difference in the achievement test scores between the students who were taught mathematics with DGS and CAS and the students who were taught mathematics traditionally. The t-test for independent samples was used to test if a significant difference exists in the attitude towards mathematics between the students taught mathematics with DGS and CAS and the students taught mathematics traditionally. The achievement of the students in mathematics were interpreted based from the NAT Achievement Level Descriptive Equivalence which had been adopted and used by the school and the mathematics department for measuring and interpreting the mastery level of the students.

Percentage Range (%)	**Mastery Level**
96 – 100	Mastered
86 – 95	Closely Approximating Mastery
66 – 85	Moving Towards Mastery
35 – 65	Average Mastery
15 – 34	Low Mastery
5 – 14	Very Low Mastery
0 – 4	Absolutely No Mastery

The Mathematics Attitude Scale was composed of 25 statements which measured the attitude towards mathematics. Students' extent of agreement or disagreement for every statement was expressed in a 5-point scale. The five choices of responses were: *Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD).*

Determining the positive and negative statements in the attitude scale was done first and the highest score of five will be given to the response indicative of the most favorable attitude. The response in the positive statements has a weighted score of 5, 4, 3, 2, and 1. The negative statements were scored in reversed order. The scoring is as follows:

Limits		**Scale**		**Response**	**Qualifying Statement**
Positive	*Negative*	*Positive*	*Negative*		
4.20–5.00	1.00–1.79	5	1	Strongly Agree	The students have positive attitude towards Mathematics
3.40–4.19	1.80–2.59	4	2	Agree	
2.60–3.39	2.60–3.39	3	3	Undecided	The students are not sure of their Attitude
1.50–2.59	3.40–4.19	2	4	Disagree	The students have negative attitude towards Mathematics
1.00–1.79	4.20–5.00	1	5	Strongly Disagree	



Schema of the Management of Classes

4. RESULTS AND DISCUSSIONS

Achievement of Students towards Mathematics:

The mean scores from the pretest and posttest result of the two groups, the experimental and the control groups, were analyzed and presented in Tables 1 and 2.

Table 1 Pretest and Posttest Achievement Scores of Students in Mathematics

Groups	N	Pretest			Posttest			Qualitative
		$\bar{x}$	%	SD	$\bar{x}$	%	SD	Description
Control	25	12.92	43.07	4.32	14.88	49.60	3.40	Average Mastery
Experimental	25	12.96	43.20	3.60	16.60	55.33	3.43	Average Mastery
Overall	50	12.94	43.13	3.94	15.74	52.47	3.48	Average Mastery

Table 2 Posttest Achievement Scores of Students in Mathematics According to their Mastery Level

Range (%)	Control Group			Experimental Group		
	f	%	Mastery Level	f	%	Mastery Level
96 – 100	0	0	Mastered	0	0	Mastered
86 – 95	0	0	Closely Approximating Mastery	0	0	Closely Approximating Mastery
66 – 85	3	12	Moving Towards Mastery	3	12	Moving Towards Mastery
35 – 65	19	84	Average Mastery	20	80	Average Mastery
15 – 34	3	12	Low Mastery	2	8	Low Mastery
5 – 14	0	0	Very Low Mastery	0	0	Very Low Mastery
0 – 4	0	0	Absolutely No Mastery	0	0	Absolutely No Mastery

The data presented in Table 1 show that students from both experimental and control group had an average mastery level on the competencies tested in the achievement test. The experimental group had higher mean scores than the students from the control group. Table 2 show that the more students from the experimental group obtained higher mastery level compared to that of the control group. The experimental group has 1 lesser student who obtained low mastery compared to that of the control group and 1 more student in the Average Mastery level.

The results in their pretest indicated that the levels of students' abilities from both the experimental group and the control group were very close and therefore comparable for the conduct of the research. However, this only served as a covariate in this study. Considering the standard deviations for the pretest, the control group got a higher value compared to that of the control group. This indicated a wider dispersion in the scores of the students in the control group.

As shown in the result, the students in the experimental group obtained higher mean in the posttest, which differs 1.72 from the control group. During the conduct of the study, the students in the experimental group were observed to have shown eagerness to learn the relationships as one variable changes in the simulation in the software. They had shown interest to learn more through manipulating different models within the simulation to discover more about the lesson. Their motivation and interest can be seen as indicated in their journal. One student said "*It made me understand Mathematics more and made it easier for me to understand the lessons*" while the other one said "*I learned to prove theorems by using the DGS and CAS software*."

The standard deviations for both groups also indicated that their responses were varied. The lower value in the standard deviation for the control group shows that their scores were closer to the mean compared to the experimental group. This means that the students from the control group, whether from high mathematical ability level or from low, were to some extent homogeneous in their achievement scores compared to that of the experimental group. The control group was taught using the traditional method which was the lecture method. The higher value of the standard deviation for the experimental group indicates that their scores were widely dispersed compared to the latter indicating that some students in the experimental group had become more confident with the use of DGS and CAS software.

In order to test the significant difference in the posttest achievement scores between those students from experimental group and those from the control group, the data gathered were subjected to One-Way Analysis of Covariance (ANCOVA). The result is presented in Table 3.

Table 3 One-Way ANCOVA to compare the Achievement in Mathematics between the Experimental Group and the Control Group

Source of Variation	Type III Sum of Squares	df	Mean Square	F-ratio	p-value
Corrected Mode	252.461[a]	2	126.231	17.289	.000
Intercept	325.021	1	325.021	44.516	.000
Covariates	215.481	1	215.481	29.513	.000
Main Effects	36.068	1	36.068	4.940	.031
Error	343.159	47	7.301		
Total	12983.000	50			
Corrected Total	595.620	49			

* significant at 0.05 level

The data in Table 3 show that there was a significant difference in the posttest scores between the students in the experimental group and that of the students in the control group. The null hypothesis which states that there is no significant difference in the achievement in Mathematics between those students taught with DGS and CAS software and those who were taught without the DGS and CAS software was tested at 0.05 level of significance. The result shown in Table 3 indicated that the main effects obtained a p-value of 0.031. Since p-value was lower than the significance level of 0.05, the null hypothesis is *rejected*.

Based on these results, the student's experiences with the help of DGS and CAS learning process had helped them obtain a higher score; hence their achievement was improved. The activities with the software could have enabled the students to broaden and deepen their understanding about their lessons through discovering the necessary concepts and relationships among models in the topic.

The result showed that the integration of Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) in teaching Mathematics significantly improves students' academic achievement. Based from the observation during the conduct of the study, students were very interested and highly motivated during the manipulations in the drawing space of the software. The software provided a very interactive and friendly environment and motivation as manifested in their active participation and making decisions based on their observation. This could further show that the students taught using the software performed better compared to the students taught without it.

The integration of the software provided activities that were more student directed. Students from the experimental group were observed to be very inquisitive about the effects of varying one variable in the simulation into another. On the interviews conducted, one student said "*I like the feature of the software that it gives us directly the information we need for us to see the relationship of the lines and angles of the circles."* The other student also claimed "*With the use of the DGS I can show the proof of how the theorems work."*

Many studies conducted reveal similar findings to the study conducted. Coraje (2009) showed that the ICT integration in the Advanced Algebra was effective, as it showed an improvement in the students' achievement test. The result of the study is also parallel with the result of Dogan (2011) whose findings revealed that students' in experimental group who were exposed to classroom teaching, laboratory experiments, computer simulated activities achieved significantly higher academic achievement than their counterparts in the control group who were exposed to traditional classroom.

However, suggestions were still made that teaching with CAI should be used to supplement the teacher directed instruction to further familiarize the students in the teaching using computer technology as this is needed for the competitive education of the computer age.

Attitude of Students towards Mathematics:

The 25 item Mathematics Attitude Scale adopted from Aiken was used to obtain data to answer the second problem. Table 4 presents the mean and standard deviation of attitude of students in Mathematics between those who were taught with DGS and CAS and those taught without the use of DGS and CAS.

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As shown in Table 4, the overall mean scores showed that both groups have rated *Agree* in terms of their attitude towards Mathematics. However, the means differed by 0.072 in favor of the experimental group indicating that these students displayed more positive and favorable attitude towards Mathematics compared to the students from the control group. This could mean that the integration of DGS and CAS learning process in teaching Mathematics subject helped broaden positive and favorable attitude of the students in the experimental group towards the software and to the subject itself.

There were 6 items from the attitude scale that both experimental group and control group generated the same positive attitude. Both groups agreed that when they worked with problems in Mathematics, their thinking and reasoning were sharpened. They both agreed that they were excited on the subject.

Table 4 Students Attitude Scale towards Mathematics

Items	Experimental Group			Control Group		
	$\bar{x}$	SD	QD	$\bar{x}$	SD	QD
*Mathematics is a subject I am afraid of.	2.84	1.14	U	2.68	1.18	U
When I work with problems in Mathematics, my thinking and reasoning are sharpened.	3.72	0.89	A	3.92	0.95	A
*I am unable to think clearly when working with Mathematics	2.84	1.07	U	2.92	0.81	U
I feel excited learning about Mathematics	3.56	0.92	A	3.76	0.83	A
*Study of Mathematics is not important unless you are an engineer.	4.28	0.79	SD	4.24	0.93	SD
*Learning Mathematics makes me feel bored.	3.76	0.97	D	3.68	0.95	D
*I feel bored listening to people taking about Mathematics	3.68	0.85	D	3.68	1.07	D
Mathematics is a topic I greatly enjoy.	3.16	0.94	U	3.48	0.71	U
*Of all my teachers, I like Mathematics teacher least.	3.72	0.98	D	3.20	0.96	U
Being with people who are good in Mathematics is enjoyable	3.96	1.02	A	3.80	1.00	A
*No matter how hard I try, I cannot understand Mathematics	3.56	0.96	D	3.44	0.96	D
I feel happier in my Mathematics class than in any other class.	3.00	0.71	U	2.72	0.84	U
Mathematics gives me such satisfaction.	3.48	0.77	A	3.40	0.65	A
*Mathematics is not necessary in our country.	4.48	0.82	SD	4.60	0.65	SD
I find Mathematics useful for problems of everyday life.	4.04	1.06	A	4.12	0.78	A
*I don't enjoy going beyond the assigned work in Mathematics	3.52	1.05	D	3.12	0.83	U
I feel I have a good foundation in Mathematics.	3.16	0.85	U	3.00	0.82	U
*I study Mathematics just to pass the year level.	3.40	1.12	D	3.36	1.25	U
*I feel nervous in Mathematics class.	2.80	1.00	U	2.72	1.10	U
I have a feeling I can get high grade in Mathematics.	3.08	0.86	U	2.88	0.78	U
*I feel uncomfortable listening to Mathematics.	3.32	1.11	U	3.60	0.50	D
*I would not enjoy working with Mathematics.	3.80	0.87	D	3.44	0.77	D
Learning Mathematics makes me feel great.	3.88	0.93	A	3.60	0.87	A
*Being with people who are good in Mathematics is boring.	4.12	0.83	D	4.08	0.49	D
I am confident when solving Mathematics problems.	3.08	1.08	U	3.00	1.08	U
Overall	3.530	0.469	A	3.458	0.555	A

Legend: SA – Strongly Agree A – Agree U – Undecided D – Disagree
SD – Strongly Disagree

* – negatively stated statements

They enjoyed with people who were good in Mathematics. They both feel great in learning with the subject that it gives them satisfaction, and it was very useful for problems of everyday life. This could mean that whatever teaching approach their teachers were using, they still believed that the subject had a positive effect on their attitude.

Six statements were rated by both groups with unfavorable attitude. Both the experimental and the control groups disagreed that the subject was not necessary unless you're an engineer; that learning math and listening to people talking about math is boring. They disagreed that no matter how hard they try they can't understand math and that people who were good in this subject were boring.

There were three statements from the scale that the experimental group disagreed; while, the control group were undecided. The statements were that: Of all my teachers, I like Mathematics teacher least; I don't enjoy going beyond the assigned work in Mathematics; and, I study math just to pass the year level. From the unstructured interview conducted, some students said *"I like the Mathematics class if our teacher will use the software in making his discussions."* Other student said "*It feels like I am holding the concept in my mouse and all I have to do is to figure it out by moving the objects in the drawing space."* These interviews may have answered the statements why the students from the experimental group had a positive attitude towards these negative statements.

The experimental group rated one statement Undecided and the control group rated Disagree. The students who were taught Mathematics with DGS and CAS felt uncomfortable listening to Mathematics while the students from the traditional setting has disagreed on this. The self-discovery approach of the ICT integration in the classroom and the constructivist learning processes used by the teacher might have affected the preference of the students in terms of learning strategies. They prefer more to be engaging themselves to guided activities in the mathematics classroom rather than spending the entire session listening to teachers as the primary source of instruction and information.

The data further show that the integration of the Computer-Assisted Instruction as an instructional tool develops the students reading and communication skills necessary for them to execute properly the instructions to be followed. They can participate in the discussion with the use of DGS and CAS especially if it employs animation, motion or graphics since this can enhance their understanding. When DGS and CAS are used in the mathematics class they become more participative by giving additional information. Moreover, they can easily understand new ideas and concepts thus this stimulates their attention in the class. Computers being used as instructional tool ease boredom of the students.

The result could further show that the integration of the software learning process helped the students to deviate from what was the control group were rating. This result supports the claims of Lunce (2006) that educational simulations have a number of advantages over other instructional methodologies and media. Students often find active participation in simulations to be more interesting, intrinsically motivating and closer to real world experiences than other learning modalities. As observed, the students from the experimental group showed their enthusiasm in learning with the use of DGS and CAS. They actively participated in the activity and in the class discussion. Excitement and eagerness to learn was also observed, since the students rush to the computer laboratory upon hearing the bell for their scheduled time and even wanted to stay even when the time was over.

Both the experimental group and the control group were undecided on the following eight statements: Mathematics is a subject I am afraid of; I am unable to think clearly when working with math; math is a topic I greatly enjoy; I feel happier in my math class than in any other class; I feel I have a good foundation in math; I feel nervous in math class; I have a feeling I can get high grade in math; and I am confident when solving math problems. The overall findings show that the students in the experimental group who were taught with DGS and CAS tends to have positive attitude towards the subject; while, the students who were not exposed to this learning environment stayed undecided and uncertain in making more favorable decisions about how they feel towards Mathematics.

Moreover, Table 4 showed that the standard deviation of the experimental group was lower compared to the standard deviation of the control group. This shows that there was a lesser variation on the attitude scores of the experimental group that cluster towards the mean. This indicates that the experimental group is more identical in their attitude towards the subject. The control group had a higher standard deviation indicating that their attitude scores were more varied and scattered.

To test the significant difference in the attitude towards mathematics between the experimental group and the control group, t-test was employed. The test analysis is presented in Table 5.

Table 5 Test of Significant Difference in the Attitude towards Mathematics between the Experimental Group and the Control Group

Groups	$\bar{x}$	SD	df	t-value	p-value
Experimental	3.5296	0.55525	48	0.495	0.623
Control	3.4576	0.46934			

* significant at 0.05 level

The null hypothesis which states that there is no significant difference in the attitude towards Mathematics between those students taught in Mathematics with DGS and CAS and those who were taught in Mathematics without DGS and CAS was tested using t-test at 0.05 level of significance. The result shown in Table 5 indicated a p-value more than the significance level of 0.05. As a result, the null hypothesis is *accepted*. Therefore, there is no significant difference in the attitude towards Mathematics of students when taught with DGS and CAS than those who were taught without DGS and CAS. The p-value was not sufficient to warrant the claim that teaching students with DGS and CAS influences the attitude of students towards Mathematics. The result is shown by the responses given by both groups in the attitude scale wherein a number of statements from the attitude scale were rated equally as undecided. However, as shown in Table 5, the data indicates that the experimental group had a higher mean rating compared with that of the control group.

Students from the experimental group suggested in their journal prompts that the use of the software must be implemented throughout the curriculum for the learning process gave them easier ways to deal with the subject. One of the students said "*I've learned many things in the software like when the central angle and inscribed angle have the same intercepted arc, the measure of the inscribed angle is one-half the central angle."* Reactions of the students during their activities and their responses to the interview manifest that they like doing Mathematics with the help of DGS and CAS.

The findings conform to the study of Alaj (2006), Al Senaidi (2008), and Mehdiyev (2009) who both investigated the effects of CAI both in the achievement and attitude of students. The results showed that the dynamic software DGS and CAS has a positive effects on students' motivation towards learning together with their achievement.

Lunce (2006) mentioned, that there are a number of disadvantages in the use of computer simulation that could be a factor why this study did not reveal a significant difference from the attitude of the students. One student in the interview said, *"I like it more in the chalk and talk discussion because I can understand more if the teacher will explain the lesson."* Another student said, "*The tools of the DGS and CAS are very hard to manipulate, I'm always confused on which tool is to be used to create figures and models."* This could have been one of the reasons why not all studies resulted to positive results. These results also suggested that the complexity of the software must be addressed first, proper and enough orientation on how to use them must be conducted to avoid these reactions.

Consequently, the findings of the study provided insights that the use of DGS and CAS in teaching Mathematics, could help improve mathematics achievement of students. Furthermore, the use of DGS and CAS in teaching Mathematics could motivate the students to learn and could enhance their preference, hence favorable attitude towards Mathematics.

5. FINDINGS

From the analysis of data, the following findings were derived:

1. There is a significant difference in the mathematics achievement of students in Mathematics when taught with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) compared with those who were taught without Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) in favor of the experimental group.

2. There is no significant difference in the attitude of students in Mathematics when taught with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) compared with those who were taught without Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS).

6. CONCLUSIONS

The following can be inferred from the findings of the study:

1. With the significant difference in the academic achievement between students taught with Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) (experimental group) and students taught without Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) (control group) favoring the experimental group, then Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) could be used to enhance students' capabilities in understanding Geometry.

Students who were taught with DGS and CAS had higher scores in Mathematics and showed competence in knowledge and skills compared with those in the control group who were exposed to conventional teaching. Therefore, the integration of DGS and CAS in Mathematics lessons leads to better academic achievement result compared with that of the conventional method of teaching.

2. The students being exposed to Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) learning environment have the same preference and outlook with the students from conventional math class.

7. RECOMMENDATIONS

Based on the aforementioned findings, the following are recommended:

1. Mathematics teachers are encouraged to integrate the Dynamic Geometry Software (DGS) and Computer Algebra Systems (CAS) in the learning process to enhance students learning and academic performance.

2. Trainings for the relevant skills could be done adequately to promote positive attitude towards Computer – Assisted Instructions.

3. Instructional materials not just for grade 10 but to all areas in mathematics could be developed.

4. Further studies about strategies and learning process integrating Computer – Assisted Instructions could be done to provide sufficient claims on positive results on students' performance and their attitude towards Mathematics.

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