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Software-Based Circle Technology in Dinagat Geometry Class: A Single Subject Research

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Abstract
Present study investigated the effectiveness of the use of technology software-based instruction in learning Circle Geometry, the extent of the students' interest on the use of this strategy, and designs a classification model through Discriminant Analysis forcasting students' performance as to having mastered or not the lessons based on their interest on the use of the strategy. The study utilized single subject research design to the thirty-one Grade 10 students in Llamera National High School, Dinagat Islands Division. Trend analysis and repeated ANOVA results revealed that most students' performance in circle geometry improved throughout the intervention of technology software-based instruction and the gap between the high achieving and low achieving students was reduced. Students also perceived high interest in learning geometry through the intervention. Indeed, technology software-based instruction recuperates knowledge in Circle Geometry. Accordingly, the capability to visualize the lesson through the software-based instruction is the best predictor of the students' mastery in circle geometry.

Keywords: Circle, Discriminant analysis, Single subject research, Software-based instruction technology.

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INTRODUCTION

Mathematics is considered as a tough subject to learn for most students. It involves not just numerical symbols but also concepts which require deep analysis. Thus, it requires extra effort for some and can be complicated to others (Alegria, 2017). One of the basic topics in secondary mathematics curriculum as included in the spiral progression of the K to 12 program is about circles in which the students are expected to demonstrate understanding of key concepts of circles and coordinate geometry (K to 12 Curriculum Guide in Mathematics, 2016). This concept is always associated with all of the succeeding lessons involving principles from different disciplines which eventually not mastered by students.

Aside from that, it is also found out that most teachers find it moderately difficult to effectively make illustrations of concepts on circle in a chalkboard and even present the topic in a way that the students are enabled to grasp and construct the relevant mathematical knowledge (Ogbonnaya & Alfred, 2017). These findings are observed in our classroom setting which could account for the students' difficulties and poor achievement in circle geometry.

The fact that it is considered a significant part as foundation in learning coordinate geometry, it is important that this concept is inculcated, harnessed and be mastered by the learners. With this, it is the viewpoint of the researcher to provide

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alternative strategy to improve student's learning performance and that is to make use of mathematical technology software such as GeoGebra.

In remote areas like Dinagat Island, advancement in technology was experienced late. Just recently that the schools in the island are now equipped with computers provided by the government. The use of mathematical technology software as supplement to teaching is still an exploration to many teachers in the island. And hence, to be able to embed such in the class routinely, studying its effectiveness is important.

Several studies conducted the use of software and proven to be effective. According to Alkhateeb and Al-Duwairi (2019), the use of software in teaching geometry facilitated the students' understanding of the geometry concepts wherein the material assisted the students in learning geometry easily. In fact, Chen and Chan (2019) stressed that the use of software significantly improves children's vocabulary learning. Although students' engagement in learning software is theoretically and empirically supported to increase learning outcomes and proven to result a positive impact on students' achievement (Ogbonnaya & Alfred, 2017; Shadaan & Leong, 2013), the question on how does it stimulate students' learning and interests to actively engage in a class remain frequently known due to few existing scholarly studies and literatures.

To this end, these reasons prompted the researcher to come up with a study that is not only aimed at finding out the effectiveness of the use of GeoGebra in the whole duration of learning circle geometry but also come up with a classification model that will predict students' performance based on the level of interest and learning of the students in the strategy.

This study was anchored on the Constructivist Theory which is based on the idea that learner constructs new knowledge by applying old understandings to new ideas and experiences which is suitable for student-centered learning environments (Flemmer, 2009). Particularly, Vygotsky's social constructivism was emphasized as learners developed interaction with teachers and other learners to highlight the importance of sharing and teacher's role as facilitator in guiding the students to learn and develop positive attitude (Hursen & Ertac, 2015). Constructivism in education becomes an overarching theory for this study as concepts on constructivism such as assimilation and accommodation were considered in the creation of student's new understandings. Assimilating caused the students to incorporate new idea into what they already know (Heick, 2019) wherein student's knowledge on circle geometry from their previous grade levels (Grade 5-7) was expanded as they learnt the profound competencies set for Grade 10 under the K-12 curriculum.

On the other hand, accommodation facilitated in reshaping students' existing ideas in response to new information and method (Schulte, 1996) wherein students formed their own interpretations through shared understanding with the assistance of GeoGebra tool as they were able to explore and visualize on their own. Hence, this study enabled the students gain a different insight (assimilation) and developed a different manner of understanding (accommodation) circle geometry concepts. Moreover, this study was also anchored on the researcher's point of view based upon the study conducted by Greefrath, et.al.(2018) that in order for students to learn their attitude toward learning (interest) with the dynamic geometry software must be considered. This conforms to the idea of Harackiewicz et al. (2016) stating that interest must be promoted in education as it is considered as a powerful motivational tool that energizes learning, guides academic trajectories, and is essential to academic success.

The study's result will enable a teacher to come up with an idea on the level of students' success prior the implementation of the intervention in learning the topic; thus, it will give a picture on what teaching approaches to be highlighted and be used to help students learn and master the lesson. More specifically, this study answered the following objectives: (a) determine the mean scores of the pre-tests administered to the Grade-10 students prior to the implementation of technology software-based instruction in teaching circle geometry; (b) determine the mean gains of the students' performance after the implementation of technology software-based instruction in teaching circle geometry; (c) Investigate significant difference on the academic performance of the students between their scores in the pre-test and mean gains; (d) to measure the extent of the student's interest on using technology software-based instruction affect in learning circle geometry; and (5) design a classification model to predict students' performance after the intervention based on the level of interest they have in using technology software such as GeoGebra.

RESEARCH METHOD

Research design

This study utilized single subject research design which rigorously tested the success of an intervention on a particular classroom process (Hitchcock, 2012). Particularly, this study made use of AB-design or the basic interrupted time series design in which students' baseline knowledge on circle geometry is established then the intervention is introduced at a different time to the subject (Siegle, 2015; Ferron & Rendina-Gobioff, 2014). With this, 3 sets of pretest were used in determining the baseline scores of the students and a 5 weekly assessment tools were used to determine student's performance/trend scores every after a week lessons. The diagram of the research design for this study is shown in Figure 1.

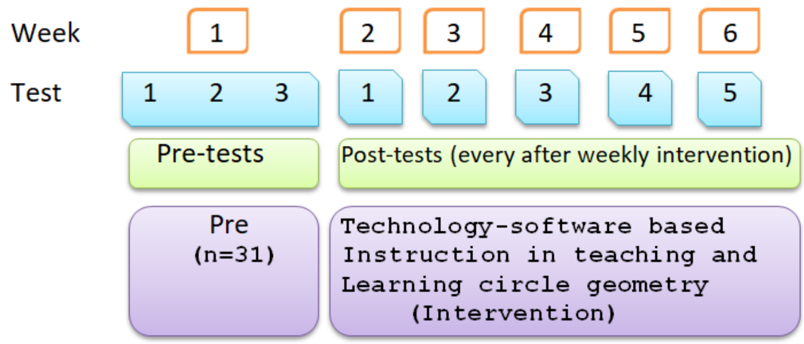

Figure 1. Research design diagram for the technology software-based instruction

Based on the diagram, 3 sets of pretest were conducted before the implementation of the intervention in order to determine the prior knowledge (baseline phase) of the students in circle geometry. After that, intervention was conducted and 5 weekly assessment tools were utilized in order to determine student's performance/trend scores every after a week lessons which allowed the researcher to diminish the internal validity threats such as history, maturation and testing (intervention phase). Moreover, to highlight novelty in this study, student's interest on the use of technology software-based instruction as an intervention was also investigated to conform the idea that student interest in a class facilitated by teaching intervention must be considered in order to see potential changes on improving student understandings of concepts (Romine et al., 2013). Hence, the independent variable was the use of technology software in teaching and the dependent variables were the achievement of the students in the lesson and the level of interest.

Research context and participants

The present study was conducted at Llamera National High School, Brgy. Llamera, Libjo, Dinagat Islands. It utilized the Grade 10 classroom and school's computer laboratory. This school is a non-implementing unit school barangay school and it is on its 10th year of providing quality education to every secondary student of the barangay. Moreover, out of 9 teachers in this school, there is only one (1) Mathematics teacher who happens to be the primary author.

The participants of the study were the thirty-one (31) Grade 10 students (14 male and 17 female) of Llamera National High School for the school year 2019-2020. These students have Mathematics subject as one of the course offerings under the K-12 Curriculum. They are the direct students of the researcher starting from the opening of the class in June 2019.

Research instruments

The study utilized a learning module entitled, "Using GeoGebra to Explore Properties of Circles in Euclidean Geometry" by Erin Hanna (2018) and Daily Lesson Logs (DLLs) as guideposts in teaching Mathematics 10 lessons particularly on the topics on circle geometry: basic terms of circle, tangents, arcs and central angles, arcs and chords, inscribed angles, other angles, circles and lengths of segments, distance formula, equation of a circle, graph of a circle & other geometric figures, and solving problems involving Plane Coordinate Geometry.

To evaluate student's achievement before and after the implementation of the intervention, 3 parts researcher-made test (pre-test), 15-item each part, were employed in succession in order to determine the based scores of the students on their level of comprehension on the competencies of circle geometry under K-12 curriculum. Also, 5 weekly assessment tools were used to determine student's performance/trend scores every after a week lessons. This allows researcher to diminish the internal validity threats such as history, maturation and testing. Another instrument that was utilized by the researcher is the student-attitudinal survey from Praveen, S. & Leong, K. E. (2013) that highlighted student's interest on the use of technology software in teaching circle geometry.

To ensure the construct validity of the research instruments, these were subjected for scrutiny by the research adviser and 2 experts in the field in teaching Mathematics 10. As to the pre-test tool, a pilot testing was done to the parallel non-respondents who were the Grade 10 students of Rosita National High School. In as much as there is only 1 section in the school under study, a pilot testing was conducted to another 30 students in the neighboring school where validity was made for this purpose. Using the Classical Test Theory on item analysis, the reliability was set revealing that reliability statistics showed a high level of internal consistency (see summary in Table 1). The instruments were then revised based on the results of the validity and reliability test.

Table 1. Reliability Level of Instrument

Statistics	Value
Number of persons	30
Minimum observed score	11
Maximum observed score	321
Mean score	16.73
Standard deviation	5.15
Interquantile range	7.75
Cronbach's alpha	0.63
Guttman's Lambda 6	1
Omega Total Reliability	0.89
Average inter-item correlation	0.03

Some items (i3 i8 i9 i18 i19 i20 i22 i23 i24 i25 i26 i30 i32 i34 i35 i39 i40 i41 i42 i46 i48 i50) were negatively correlated with the total scale and probably should be revised or replaced.

Ethics and data gathering procedure

The details on the process for the conduct of the study begin with the ethical procedure. The researcher sent letters asking permission for the conduct of study and administration of the questionnaires and instruments to the schools division superintendent, parents of the students, and school heads.

Next is the planning stage. The researcher looked for software, module, and student interest test on the use of technology in teaching math that can be adapted and be utilized in teaching Circle Geometry. Also, letter requests to grant for use of the instruments was sent and waiting for its approval. The Development of Instruments follows. A 5-week lesson log and weekly tests or assessments that were considered as the study's guideposts and assessment tool were developed.

Validation and revision of the instruments were done next. The instruments were scrutinized by the research adviser and 2 experts in the field of Mathematics in DepEd-Dinagat Division to check construct validity taking into account the competencies of circle geometry under K-12 curriculum. The experts rated the instruments as to clarity of directions and items, presentation/organization of items, suitability, adequateness, attainment of purpose, and objectivity. As to the pre-test tool, a pilot testing was done to the Grade-10 students of a neighboring school then results were analyzed through Classical Test Theory Item Analysis for item analysis and reliability of the test instrument. After that, revision on the instruments was done

The implementation stage was then conducted. A 5-week long intervention was done and the procedure is presented in Table 2.

Data analysis

It was done in order to determine the level of student's interest and performance on the use of technology software such as GeoGebra in teaching and learning circle geometry. In the same way, data analysis was conducted to be able to come up with a classification model that will be used in order to predict student's performance as to having mastered or not mastered the lessons in circle geometry.

Mean and standard deviation were used to describe the level of performance of the students before and after the conduct of the intervention as well as their level of interest with technology-based instruction.

Table 2. Intervention log on the use of software-based instruction technology

Week	Competency[a]	Session 1	Session 2	Session 3	Session 4	Session 5
1	Diagnose prior knowledge in Circle Geometry			Pre-test I	Pre-test II	Pre-test III
2	M10GE-IIc-1, M10GE-IIc-d-1	Lesson 1: Circle: Basic Terms with Familiarization of GeoGebra tools	Enhancement activity for Lesson 1(Part I, II)	Lesson 3: Arcs and Central Angles with Enhancement activity (Part I)	Enhancement activity for Lesson 3 (Part II, III)	Assessment on Lessons 1 & 3
3	M10GE-IIe-1, M10GE-IIe-f-1	Lesson 2: Tangents with Enhancement activity (Part I, II)	Lesson 5: Inscribed Angles with Enhancement activity (Part I, II, III, IV, V)	Lesson 7: Circles and Length of Circles with Enhancement activity (Part I, II)	Enhancement activity for Lesson 7 (Part III)	Assessment on Lessons 2, 5, & 7
4	M10GE-IIf-2, M10GE-IIg-1, M10GE-IIg-2	Lesson 6: Other Angles with Enhancement activity (Part I, II)	Enhancement activity for Lesson 6 (Part III, IV)	Lesson 8: Distance Formula with Enhancement activity (Part I)	Enhancement activity for Lesson 8 (Part II)	Assessment for Lesson 6 & 8
5	M10GE-IIg-2, M10GE-IIh-1, M10GE-IIh-2	Enhancement activity for Lesson 8 (Part III)	Lesson 9: Equation of a Circle with Enhancement activity (Part I)	Enhancement activity for Lesson 9 (Part II)	Enhancement activity for Lesson 9 (Part III)	Assessment on Lesson 8(Geometry properties) & 9
6	M10GE-IIi-1, M10GE-IIi-j-1	Lesson 10: Graph of a Circle & Geometric Figures with Enhancement activity (Part I, II)	Enhancement activity for Lesson 10 (Part III)	Lesson 11: Solving Problems Involving Plane Coordinate Geometry with Enhancement activity	Enhancement activity for Lesson 11 (Supplementary part)	Assessment for Lesson 10 & 11, Survey on student interest

[a]M10GE-IIc-1: Derives inductively the relations among chords, arcs, central angles and inscribed angles
M10GE-IIc-d-1: Proves theorems related to chords, arcs, central angles, and inscribed angles
M10GE-IIe-1: Illustrates secants, tangents, segments, inscribed angles and sectors of a circle
M10GE-IIe-f-1: Proves theorems on secants, tangents, inscribed angles and segments
M10GE-IIf-2: Solve problems on circle
M10GE-IIg-1: Derives the distance formula
M10GE-IIg-2: Applies the distance formula to prove some geometric properties
M10GE-IIh-1: Illustrates the center and radius form of the equation of a circle
M10GE-IIh-2: Determines the center and radius of a circle given its equation and vice versa
M10GE-IIi-1: Graphs a circle and other geometric figures on the coordinate plane
M10GE-IIi-j-1: Solves problems involving geometric figures on the coordinate plane

Repeated measures ANOVA was conducted to determine statistically significant differences in mean scores and standard deviations of the 8 achievement tests among pre-tests and post-tests throughout the intervention period (the students' level of comprehension in circle geometry). Repeated measures ANOVA was used because the sample size did not allow for a MANOVA (Stevens, 2002), as the latter analysis has sample size and condition requirements that were not met with the class design. Post-hoc Tukey's Honestly Significant Difference (HSD) Test was analyzed when significant differences were identified in order to find which means were significantly higher or lower than other means.

Discriminant analysis (DA) was conducted to investigate how the students' interest towards technology software-based instruction contributes to the distinction of the students' performance improvement with the said instruction. This was also used in order to come up with a classification model which aids in classifying the students' performance as to not mastered or mastered the lessons based on their interest.

DA is a parametric technique to determine which weightings of quantitative variables or predictors best discriminate between 2 or more than 2 groups of cases and do so better than chance. The analysis creates a discriminant function (Z) which is a linear combination of the weightings and scores on these variables:

$$Z_{jk} = a + W_1 X_{1k} + W_2 X_{2k} + \cdots + W_n X_{nk} \quad (1)$$

where

Z_{jk} = Discriminant Z score of discriminant function j for object k.
a = Intercept.
W_i = Discriminant coefficient for the independent variable i.
X_j = Independent variable *i* for object *k.*

The maximum number of functions is either the number of predictors or the number of groups minus one, whichever of these two values is the smaller (Ramayah et al., 2010). Moreover, sometimes the focus of the analysis is not just to predict but to explain the relationship, as such, equations are not normally written when the measures used are not objective measurements.

In a 2 groups discriminant function, the cutting score will be used to classify the 2 groups uniquely. The cutting score is the score used for constructing the classification matrix. Optimal cutting score depends on sizes of groups. If equal, it is halfway between the two groups centroid. The formula is shown below:

Equal group:

$$Z_{CS} = \frac{N_A Z_B + N_B Z_B}{N_A + N_B} \quad (2)$$

where:

Z_{CS} = Optimal cutting score between group A and B.
N_A = Number of observations in group A.
N_B = Number of observations in group B.
Z_A = Centroid for Group A.
Z_B = Centroid for Group B.

Unequal group:

$$Z_{CE} = \frac{Z_A + Z_B}{2} \quad (3)$$

where:

Z_{CE} = Optimal cutting score for equal group size.
Z_A = Centroid for Group A.
Z_B = Centroid for Group B.

In the context of this paper, the two unequal groups considered are the participants with not mastered performance and the other one with mastered performance. Moreover, assumptions of DA were satisfied by the sample data. Unequal sample sizes are acceptable. The data obtained is approximately normally distributed using Shapiro Wilks test (see Table 3). Using Stem-and-leaf Plot and Boxplot, it was found out that there were no outliers for every variable. Homogeneity of variances/covariance was also met and there was low multicolinearity of the independent variables (on interest) as shown by the correlation matrix.

Table 3. Shapiro-Wilks Test for Normality.

Tests of Normality	Shapiro-Wilk			
Interest	Statistic	df	p*	Remark
Statement1	0.684	5	0.6	Not Significant; Normal
Statement2	0.58	20	0.09	Not Significant; Normal
Statement3	0.684	5	0.32	Not Significant; Normal
Statement4	0.524	26	0.08	Not Significant; Normal
Statement5	0.492	30	0.47	Not Significant; Normal
Statement6	0.345	11	0.07	Not Significant; Normal
Statement7	0.533	21	0.58	Not Significant; Normal
Statement8	0.39	9	0.22	Not Significant; Normal
Statement9	0.499	15	0.09	Not Significant; Normal
Statement10	0.57	21	0.1	Not Significant; Normal

*p > 0.05

RESULTS AND DISCUSSION

This section presents the analysis and interpretation of the gathered data from the respondents. The results and discussions of the gathered data are arranged to answer the problems posed.

Table 4. Participants' mean score in the pre-test

Pre-tests	Mean	sd	Rating	Qualitative Description
Stage 1	4.71	1.77	31.4	Not Mastered
Stage 2	3.48	2.11	23.2	Not Mastered
Stage 3	3.35	1.99	22.3	Not Mastered
Average Pre-test	3.85	1.26	25.7	Not Mastered

As gleaned from Table 4, the participants during the pre-test along three (3) stages have shown the following mean scores respectively; (M=4.71, M=3.48, M=3.35) with equivalent ratings of (31.4%, 23.2%, 22.3%) qualitatively described as "not mastered"; it can also be seen that participants got an average pre-test score of 3.85 and a standard deviation of 1.26 with an equivalent rating of 25.7% that is also qualitatively described as "not mastered". From this, it can be inferred that these results can be attributed to the students' lack of background knowledge on circle geometry.

On the other hand, Table 5 displays the participants' mean gains after the implementation of Technology Software-Based Instruction in teaching circle geometry.

Table 5. Students' average performance after implementation of technology software-based instruction

Post-tests	Mean	sd	Rating	Qualitative Description
Week 1(W1)	12.32	0.54	82.13	Mastered
Week 2(W2)	13.29	0.43	88.6	Mastered
Week 3(W3)	12.97	0.27	86.47	Mastered
Week 4(W4)	11.16	0.3	74.4	Almost Mastered
Week 5(W5)	12.84	0.19	85.6	Mastered
Average Score	12.52	0.35	83.47	Mastered

It can be seen in the table that the participants during the posttest along five (5) weekly assessments have shown the following mean scores respectively; (M=12.32, M=13.29, M=12.97, M=11.16, M=12.84) with equivalent ratings of (82.13%, 88.6%, 86.47%, 74.4%, 85.6%) qualitatively described as "mastered" for week 1, 2, 3, 5 and "almost mastered" for week 4; it can also be seen that participants got an average posttest score of 12.52 and a standard deviation of 0.35 with an equivalent rating of 83.47% qualitatively described as "mastered". With this, it can be noted that the notable increase in the students' academic performance after the implementation of the strategy signifies high level of comprehension on learning the concept of circle geometry. Hence, it can be accentuated that exposure to technology software-based instruction contributed in gaining students' remarkable level of comprehension.

Table 6. The ANOVA of Students' Achievement Levels among Pre-test and Post-tests

Assessment Process	Mean	Sd	F-test Statistic	P-value*	η^2	Remark
Pre-test	3.85	0.23	392.652	0	0.97	Significant
Post-test 1	12.32	0.54				
Post-test 2	13.29	0.43				
Post-test 3	12.97	0.27				
Post-test 4	11.16	0.3				
Post-test 5	12.84	0.19				

*$p < 0.05$ significance level

The results in Table 6 showed that the students' individual achievement performances were statistically significantly improved from pre-tests to post-tests. Within the five stages of the post-tests, statistically significant improvement was also identified. As the repeated ANOVA is significant, this indicates that the individual performance levels in circle geometry were statistically significantly enriched after the intervention with p-value less than 0.0001. Large effect sizes were found in students' achievement tests before and after the intervention with η^2 equals 0.97 in which this result could be accounted not only on the use of the software-based instruction but also of having a social constructivist classroom highlighting the importance of sharing and teacher's role as facilitator in order to learn (Hursen & Ertac, 2015).

Furthermore, the students' performance in the post-tests on week 1, 2, 3 and 5 were found to have the same remarkable improvement. However, their performance in week 4 post-test significantly varies from the rest of the post-tests. As observed from the mean scores, the students got the least improvement in the week 4 post-test, concerning the use of Distance Formula to Geometric Properties and Equation of a

Circle. This finding could be accounted to students' misuse of distance/length and angle tools in GeoGebra as observed during class sessions leading to incorrect results in answering distance problems and as to students' performance on dealing with problems involving Equation of a Circle, it is observed that few of them have difficulties on recalling and applying previous knowledge on Algebra that is helpful in finding equations. According to Gonzalez & DeJarnette (2013), circle problems provide every student the opportunity to review theorems and properties in geometry and algebra that they had previously studied and to apply those theorems in a new context.

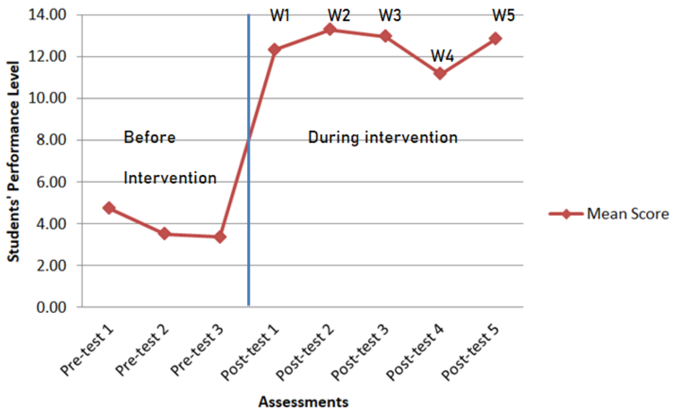

Figure 2. Trend of the Students' performance level from pre-tests to post-tests

As illustrated in Figure 2, the descriptive statistics analysis demonstrated a noticeable pattern of both improvements of means and reduction of standard deviations on the students' performance levels from pre-tests to post-tests. This finding indicates that not only did most students improve their average performance in circle geometry throughout the intervention of technology software-based instruction, but also the gap between the high achieving and low achieving students was reduced. The test of significances showed students' overall learning in circle geometry were: (a) statistically significantly improved from the pre-tests to post-test 1; (b) stable at a high level from the post-test I to the post-test III; (c) statistically significantly improved less from post-test III to post-test IV; and (d) statistically improve back at a high level from the post-test IV to the post-test V.

Students' perceived interest on the use of technology software-based instruction in teaching Circle Geometry is presented in Table 7. Participants showed strong affirmation that through the use of technology software specifically GeoGebra in the class enabled them to visualize the concepts related to circle geometry, enjoy much more learning mathematics, learn a lot about circles, form better constructs in connecting previous and new learning, and even enhance their confidence in engaging to class activities.

However, they stated that they were not so creative and being critical thinker in the discussions and question-and-answer sessions, and were not so logical in making assumptions when attempting to hypothesize based on the obtained mean scores of 3.48 and 3.08; respectively, with a qualitative description of agree. Based from the result, it can be deduced that the use of technology software-based instruction benefited the teacher and students.

Table 7. Perceived interest on the use of technology software-based instruction

Statement	Mean	SD	Qualitative Description
S1. I was excited about using GeoGebra software in learning circle and coordinate geometry.	3.92	0.19	Strongly Agree
S2. I learned a lot using GeoGebra.	3.68	0.24	Strongly Agree
S3. I felt confident using the GeoGebra software during activities.	3.55	0.33	Strongly Agree
S4. I was very engaged in the learning process.	3.92	0.19	Strongly Agree
S5. The use of GeoGebra in instruction benefited a lot to me as it made use of teacher-students interaction.	3.98	0.09	Strongly Agree
S6. I was able to visualize and answer the questions after each activity.	3.82	0.24	Strongly Agree
S7. I was able to think creatively and critically in the discussions and during the question and answer sessions.	3.48	0.16	Agree
S8. I was able to make logical assumptions when attempting to hypothesize.	3.08	0.45	Agree
S9. I enjoyed learning mathematics much more using GeoGebra.	3.76	0.25	Strongly Agree
S10. I was able to form better connections between previous learning and new learning when GeoGebra is utilized in the class.	3.66	0.24	Strongly Agree
Average	3.69	0.1	Strongly Agree

Furthermore, DA was applied to assess how well a student's performance improvement in circle geometry with the integration of technology-software based instruction could be predicted from 10 items from the assessment on the level of interest of the student. These ten discriminating independent variables are the items mentioned in Table 5 decoded as S1-S10. The dependent variable is the student's performance, and was recoded from numerical value to its equivalent qualitative description that reflected a better distribution of the data. These qualitative descriptions included: not mastered and mastered.

In DA, Z score is generated for developing classification model towards the students' performance improvement with technology software-based instruction in Circle Geometry based on their interest. To start with, Table 8 shows the significance test on how well the model work. Since there were only two qualitative descriptions for the dependent variable, this analysis produced only one discriminant function that was significant ($p<.05$).

Table 8. Significance test of model fitting

Test	Eigen value	% of variance	Canonical Correlation	Wilks' Lambda	Chi-square (df=10)	P-value*	Remark
Function	0.641	100	0.652	0.685	19.097	0.039	Significant

*p < 0.05 significance level

The Eigenvalues and the canonical correlations describe that the function obtained possessed a good discriminating ability. In addition, the correlation of 0.652 is comparatively high. Since there is only one function, 100% of the variance is accounted by this function. Furthermore, since $p < 0.05$, results suggest that based on the sample data, there was statistically significant discriminating power in the variables included in the model. That is, the interest of the students significantly contributes to discriminating their performance in circle geometry using Technology Software-Based Instruction as to mastered or not mastered. Hence, discriminant equation was developed.

Table 9. Canonical discriminant function coefficients

Interest	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Unstandardized coefficients	-2.84	-2.65	-1.05	4.08	-2.81	3.55	-2.10	1.12	1.52	0.55
Standardized coefficients	-0.53	-0.61	-0.34	0.76	-0.26	0.86	-0.34	0.51	0.39	0.12

Table 9 presents the values indicating the relative importance of the student's interest as independent variable to the discriminating function. The standardized coefficients indicate that the item S6 (I was able to visualize) has the highest discriminating power due to the highest magnitude of discriminant coefficient of 0.86 followed by S4, S2 while least is S10. This indicates that be able to visualize and answer every activity has a best predictor of whether the student will master or not master circle geometry with Technology Software-Based Instruction. This result relates with the study of Tay and Mensah-Wonskyi (2018) that using Geogebra method as technology software-based instruction made the lessons more interesting, practical and easy to visualize and understand.

Since predictive equation is being designed, the unstandardized canonical coefficients (in Table 8) are used in constructing the discriminant function. From the 10 predictors on the interest of the students, the discriminant function Z obtained is as follows:

$$Z = 2.36 - 2.84S_1 - 2.65S_2 - 1.05S_3 + 4.08S_4 - 2.81S_5 + 3.55S_6 - 2.10S_7 + 1.12S_8 + 1.52S_9 + 0.55S_{10}$$

In the formulation of the decision rule in classifying mastered or not mastered performance of a student, group centroids were used (see Table 10). The function of the group centroid provides the average discriminant score of the two performances. The centroids are the extreme point to formulate the decision rule.

Table 10. Functions at group centroids

Performance	Function
Not mastered (n=6)	1.34
Mastered (n=25)	-0.322

Unstandardized canonical discriminant functions evaluated at group means

Since the 2 groups viz the mastered performance and not mastered performance are not equal in number of observations, weights on the centroids were used to find the dividing point that manifest the decision rule. Thus, not mastered performance is predicted and classified if $-0.00032 < Z < 1.34$ and mastered performance if $-0.322 < Z < -0.00032$.

The predictive capacity of the discriminant function (DF) was verified through subjecting the equation to the data collected on the dependent variable. The values from the original data collected were substituted in the unstandardized discriminant function and the decision rule is used to classify the performance. The predicted group membership in the classification results gives the predicted frequencies of groups from the analysis. These are presented in Table 11.

Actually, 74.2% of the data was correctly classified as having mastered performance and not mastered performance in circle geometry through technology software-based instruction by the discriminant function (see Table 11).

Table 11. Discriminant function classification results

			Predicted Group Membership		Total
		Self-efficacy	Not Mastered	Mastered	
Original	Count	Not mastered	5	1	6
		Mastered	7	18	25
	%	Not mastered	83.3	16.7	100
		Mastered	28	72	100

a. 74.2% of original grouped cases correctly classified.

Besides, 5 students were correctly classified as having not mastered performance, out of the 6 actually not mastered. Likewise, 18 students were correctly predicted that having mastered performance, out of 25 truly having mastered performance. Thus, the accuracy of the model is considered good and adequate.

CONCLUSION

The study focused on the use of ICT in learning mathematics. The effectiveness of integrating technology software-based instruction in learning circle geometry is investigated. The said strategy is an advance approach for the schools in a remote area like Dinagat Islands.

The findings from the study indicate that if Grade 10 students are taught circle geometry integrating technology software-based instruction, they would comprehend and learn smoothly. Their performance improved far more with the interventions as technology software-based instruction is easy to understand, interesting and enjoyable, makes lesson more concrete, and enriches visualization instead of imagination of concepts and figures. In fact, students' interest especially being able to visualize and answer every activity in Circle Geometry through Technology Software-Based Instruction is the adequate estimate of whether the student will master or not master circle geometry with the said instruction. Therefore, the study concludes that technology software-based instruction is one of the answers to the poor performance in Cirlce Geometry. Thus, if the said strategy is introduced in teaching and learning Grade 10 Geometry in Dinagat Islands, ther would be an improvement in Mathematics performance.

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