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Inquiry-Based Approach in Teaching Geometry: It's Impact on Learning and Attitude of Grade 7 Junior High School

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Abstract: This study was conducted to determine the effectiveness of IBT in Geometry as well as its impact on learning and attitude of grade 7 Junior High School at Talayan National High School. IBT module in grade 7 geometry was used as an intervention to 74 IBT class covering the third quarter of the school year 2019- 2020. True experimental (IBT class and Non IBT class) and descriptive design were utilized in the study. Result revealed the significant findings that majority of the respondents in IBT class got improvement in their Geometry test scores from pre- test to post test in remembering (43 or 58%), understanding (44 or 59.4%), applying (44 or 59.4%), analyzing (40 or 54.1%), evaluating (46 or 62.2%) and creating (47 or 63.5%). Majority of the Non IBT Class in geometry have no improvement in their pre-test and post test in geometry in the categories; remembering (43 or 57.4%), understanding (54 or 72.1%), applying (53 or 70.7%), analyzing (40 or 53.4%), evaluating (37 or 49.3%) and creating (34 or 45.3 %). This signifies that conventional approach in teaching is less effective than the IBT approach. Result showed significant difference in the mean gain scores between Inquiry- Based Teaching Class ($\bar{x}$= 0.92) and non- Inquiry Based Teaching class ($\bar{x}$= 0.25) as indicated in the difference (F- value= 10.853 and p-value= 0.000). Hence, IBT is effective in teaching geometry. Result also revealed that most students strongly agree on the perceptions on use, impact and their attitudes in using IBT.

Keywords: *Inquiry-Based Approach Teaching, Geometry, Learners, Impact, Public School*.

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Introduction

Teaching and learning are important tasks in education which play a vital role in the growth and development of individual learner. Improvement in learning can be effective if teachers can maintain the interest of the learners in engaging into the learning process. Teachers must be equipped with specialization on subject matter, strategies and teaching approaches. Students' success will depend on the great extent upon how the teachers have trained them (Agsalud, 2016). Furthermore, the kind of learners produced by any school is brought by the quality of teachers and the kind of their teaching approaches towards the learners. Teaching Mathematics especially the Geometry needs an effective approach in teaching. The subject in its nature is interesting but challenging. Inquiry-based teaching is one of the approaches considered to be effective in teaching Math. It is a student centered approach to learning. Learners will be more improved when they experienced the IBT through learners' actual engagement, exploration, explanation, elaboration and evaluation. According to Kanselaar (2002) as cited by Rooney (2012), inquiry-based learning draws on constructivist ideas of learning. Constructivism's central idea is that learning is an active process in which learners construct new ideas or concepts based on their experiences and prior knowledge.

Improvements in education especially in teaching and learning have been thought in early years. This was inspired by new insights in approaches in teaching. According to Friesen (2013), emphasis on students' engagement on genuine knowledge creation and authentic inquiry draw an inspiration from Socrates questioning method and from the work of educational thinker John Dewey in the early part of 20th Century.

Emerging insights and findings in learning sciences suggest that traditional approaches to education that is recalling disconnected facts, following certain rules and operations should be replaced by learning that enables critical thinking, flexible problem solving and the transfer of skills and use of knowledge in new situation Darling-Hammond (2005) as cited by Friesen (2013). The 21st Century teaching and learning need modern approaches in teaching which are more effective than the traditional teaching methods. According to Nazreen and Naz (2013) as cited by

Andrini (2016) factors affecting low learning outcomes such as learning models use less precise model in the learning process that may lead to boredom or burnout, lack of understanding concepts and monotonous to students who are less motivated to learn. One of the models of learning that can be effective to all the students is Inquiry learning. The necessity of the 21st Century requires education to continue creating young generation to have life skills to survive and globally competitive (Silva, 2008) as cited by (Adrini, 2016).

At these instances, the study explored the impact of the IBT in Geometry in Grade 7 Junior High School at Talayan National High School to find out the significant difference of students performance before and after the intervention as well as the change in learners' perception.

Statement of the Problem

This study explored the impact of Inquiry- Based Approach in Teaching Geometry on learning and attitude of Grade 7 Junior High School at Talayan National High School during the School Year 2019-2020.

Specifically, the study sought answers to the following questions:

1. What is the mean gain score of Inquiry- Based Teaching class in terms of;

    1.1 remembering;

    1.2 understanding;

    1. 3 applying;

    1.4 analyzing;

    1.5. evaluating and

    1.6. creating?

2. What is the mean gain score of non Inquiry- based teaching class in terms of:

    2.1 remembering;

    2.2 understanding;

    2.3 applying;

    2.4 analyzing;

    2.5 evaluating and

    2.6 creating?

3. Is there a significant difference in the mean gain scores between inquiry-based teaching class and non-inquiry based teaching class?

4. What is the perception of the respondents on:

    4.1 use of Inquiry-based learning;

    4.2 impact to learning geometry; and

    4.3. attitudes towards learning geometry?

Literature Review

Inquiry- Based Teaching approach to Teaching Geometry

Effective learning is brought by effective and efficient teacher. Approaches in teaching are very important and largely contributed to the learning outcomes of the learners. According to Andrini (2016), the selection of strategies and appropriate methods will enhance students' creativity in learning. The existence of the method is very important in education, where the presence of method to facilitate the achievement of the desired objectives. Thus, a teacher has absolute method of transferring knowledge to their students. Furthermore, according to Sumiati (2009) as cited by Andrini (2016), teaching method emphasizes the learning process actively in efforts to acquire the capability of learning outcomes. One of the academic fields in education is mathematics. It significantly contributed to human mental development. Further this is very important to other fields like physics, chemistry, engineering and other sciences. According to Ayinla (2011) as cited by Fabiyi (2017) Mathematics is a pillar of all knowledge which is relevance to all disciplines. However, learning is not easy. It needs a proper approach in teaching and learning. One of the branches of mathematics is the Geometry. It is considered as one of the hardest branches of mathematics. Many students express their opinion that most geometry lessons are difficult to understand. According to the study of Fabiyi (2017), the study revealed that out of 23 concepts, eight concepts were perceived difficult to learn by students .These include construction, coordinate geometry, circle theorem and so on. Hence, it is recommended that identified difficult geometry concepts should be taught with a proper teaching approaches and instructional materials. The current educational trend today is mostly dealt with the modern way of learning. Active participation of learners in any educational endeavour is really important. The introduction of new approach in teaching has come. One of the contemporary approaches is the Inquiry- based approach in teaching. It focuses on reproducing learners who are active to learn, learners with good characteristics, confident, able to think critically and solve problems as well as socially developed and can have the ability to communicate properly.

According to Alberta Education (2010); Barron and Darling- Hammond(2008); Friesen and Jardine (2009); Perkins (2009) as cited by Friesen (2013) that the growing body of research suggests that model of education design to meet the needs of industrial past are inadequate for the challenges and opportunities facing the 21st century students. It is a challenge to design new educational or approaches to have educational reform. Traditional method of teaching that is rote learning must be aligned to the new design of teaching and learning in which it turns the learners to think critically and creatively, make discoveries through inquiries, reflections, exploration experimentation and trial and error.

This research focused on the impact of inquiry-based approach in teaching geometry. Inquiry-Based Approach in teaching or learning is an educational strategy in which students follow methods of and practices similar to those of professional scientists in order to construct knowledge (Keselman, 2003) as cited by Constantinos Manoli (2015) and others in their study "Phases of Inquiry- based learning: definition and the inquiry cycle". It is a pedagogy which will capacitate students to experience the process of creating knowledge and will leave key attributes towards learners. This is a student-centered approach and self directed learning that will make students active, self directed and active. Engagement of students is greatly emphasized in this approach in teaching as well as open-ended and hands-on activities. These activities may involve; questioning, investigating,

use of evidences to describe, explain, and predict connecting evidences to knowledge and sharing of findings.

Based on the Philippine K-12 educational program, rule II, the curriculum standards and principle, it is stated that the curriculum shall use pedagogical approaches that are constructivist, inquiry based, reflective, collaborative and integrative. "If we are only teaching what we know, our children can only do as bad as we are doing, and this is the challenge we are facing- we have to go beyond it" (Pauli, 2009, TED).

Perceptions in learning Geometry using IBT approach in Teaching

Geometry as branch of mathematics is considered as difficult subject. Most students do not have interest in learning mathematics especially the geometry. Some considered that the subject is boring and hard to understand. Despite of the importance of the subject for it has many practical applications in different fields such as in sciences like physics, chemistry, engineering and other applied sciences, students' performance in the subject is poor. According to the source National Mathematical centre (2009) as cited by Fabiyi (2017), performance of students in mathematics in West African examination council (WAEC) has remained consistently poor. Amazigo (2000) also cited by Fabiyi (2017) suggested that mathematics educators have to put up noble and spirited efforts aimed at identifying the major problems associated with the teaching of mathematics such as poor background in mathematics, lack of incentives for teachers, unqualified teachers in the system and lack of learners' interest. In addition, students' perception that mathematics is difficult, large classes and psychological fear of the subject was furthered identified as factors responsible for the performance in the subject.

Due to the above mentioned problems in learning mathematics, a move to address them shall be the primary task of every educator. Interventions must be given to the students to eliminate the gap of perceptions that learning mathematics is difficult and boring. It is the method of teaching and learning mathematics that can solve the issue.

The Inquiry-based approach in teaching gives solutions to the difficulties and lack of interest of students in learning mathematics. The approach encourages the learners to engage, explore, explain, elaborate and evaluate their performance. The inquiry-based learning will make the learners develop their own skills directly, have self directed learning, active, discover and explore actual activities. Learners will be more enhanced, increased enjoyment and interaction with students, think critically and become good problem solvers.

Geometry is considered as one of the difficult subjects to learn. However, according to Serin (2017) and others, geometry is an important branch of mathematics. It has place in education for the development of critical thinking and problem solving. Furthermore, geometrical shapes are parts of our lives as they appear almost everywhere.

The Importance of Inquiry- Based Teaching and learning

Inquiry- based Teaching and learning promotes problem solving skills, makes learners free minds' to do and think the things they wanted to do. The world is not making the learners static. Changes on them are really necessary to increase complexity throughout their lives to become even more firm and knowledgeable. Inquiry-Based Approach in Learning is even given more importance in the adage "Tell me and I forget, show me and I remember and involve me and I Learn" Franklin (1985)

Performance Bases of Inquiry-based Teaching and Learning

There are evidences that inquiry- based approach in teaching is really an effective approach towards the learning of the students especially in today's modern times. Based on the study of Abdi (2014), students who were instructed through inquiry based learning performed very well than those who engaged in a traditional method of teaching. He used 30 items pre and post tests and analyzed the data and significantly found out that significant differences between the traditional and Inquiry-based approach in teaching and learning are effective Notably, in comparison of which textbook of grade 8 in Science promotes inquiry- based instruction, findings revealed that teachers showed progress in applying inquiry- based instruction and students became more engaged in learning in the study "Science Teachers' and Students' Perceptions of the Implementation of Inquiry-Based Learning Instruction in a Middle School in Dubai" (Eltanahy and Forawi , 2019).

Hence, traditional teaching method, where teacher do all the actions, give direct instructions and outcomes are expected which resulted to students' less interest in doing their parts. This is why teachers opted to use Inquiry- Based Approach (Sanches, 2016). It is most notably that there was a significant improvement for many student subgroups in the comparison of the teacher- directed instruction against the effectiveness of Inquiry-based Instruction at a subject school in Alabama for 5^{th} grade science and mathematics in the study "Effectiveness of Inquiry based and Teacher Directed Instruction in an Alabama Elementary School" (Taylor and Bilbrey, 2012).

Furthermore, classes were improved from their pre- test to their post- test for both units but students receiving instruction through inquiry –based instruction showed significantly more improvement on the second unit in the study " Inquiry- Based Mathematics Instruction Versus Traditional Mathematics Instruction:

The effect on Student Understanding and Comprehension in Eight Grade Pre- Algebra (Ferguson, 2010). In the research papers of Kizilaslan, Sozbilir and Yasar (2012), they found out that inquiry-based teaching is a new research area in Turkey and mostly practiced in Science and Technology Education at primary level.

Critics and Arguments in Inquiry- Based Teaching and Learning

While teaching using inquiry- based is good, there were some contradicting especially in teaching mathematics. They thought that teaching mathematics using inquiry-based is difficult. However, most teachers have thought that traditional way of teaching math by figuring equations and plugging in numbers focuses only on computation. Teaching this way for years has developed such a poor reputation that students may actively dislike the subject or find it intimidating.

In Canadian context as stated by Staples (2014), Wente, (2013) and Zwaagstra, 2017) as cited by Scott (2018), there has been a substantive opposition within the popular media to curricular shifts away from traditional model of education. According to Wente (2013), school system across Canada, "have discarded" "rote" learning in favour of discovery, a process whereby which students are supposed to come up with their own solutions to the mysteries of arithmetic. In a recent editorial in Calgary Herald, Zwaagstra (2017) argued that the shift away from the teacher-directed instruction to various forms of inquiry and project-based learning with a focus on "the process of learning and not on content led to situation where "Alberta's world-renowned education system was continued to decline" (Zwaagstra,2017) as cited by Scott (2018).

From the research of Hattie and Yates (2014), staples (2014) similarly argued that explicit instruction and diligent practice that lead to automatic recall of basic facts is a prerequisite to young learners being able to make connections and see relationships in a subject area. Staples concluded that calls by Alberta Education to poster curricular shifts towards processes of inquiry and discovery are deeply "out-of-step with modern cognitive science and best practices in teaching). Within the US context, the popular blog Intellectual Mathematics (2016) highlighted a recent OECD study that found students across all 56 countries and economies who reported learning in environments, had lower scores on the science component of the PISA test (OECD, 2016b)

However, in contrary to Hattie's arguments as cited by Scott (2018), his oft-referenced study was limited in number of respects. "Piagetian" programs, which emphasize challenges that require learners to apply higher order thinking, were ranked as the second most impactful to all the approaches examined in Hattie's study. But these approaches were presented as distinct from inquiry, despite shared affinities with both guided and authentic approaches. Furthermore, the majority of studies used in Hattie's analysis were conducted in the 1980s and early 1990s.

In contrast as cited also by Scott (2018), a recent synthesis of contemporary research in "The Cambridge Handbook of the Learning Sciences" found out both guided approaches to inquiry and approaches growing out of the authentic education movement promote deeper understanding and more intellectually engaging learning experiences for students.

The Inquiry–Based Approach in Teaching and Learning

Inquiry- Based Teaching is an approach to learning where the learners are able to learn by investigating scenarios and problems through social experiences. Students are not limited to memorization of printed materials but rather perform the actual investigation of what they want to know that would satisfy their curiosity. They should also be helped broaden their knowledge and develop their skill and capacities.

According to Liang and Gabel (2005) as cited by Gutierez , inquiry –based teaching and learning is the product of the blended theories of Piaget, Vygotsky and Ausubel about the philosophical underpinning of teaching and learning known as constructivism which emphasizes the active thinking process of integrating prior knowledge with existing knowledge (Kirchner, Schweller and Clark 2006).

Moreover, Pappas (2014), mentioned that Inquiry- based learning was not a technique or practice but a process that has the potential to increase the intellectual engagement and deep understanding of learners. Learners shall develop the questioning research, communication skills, collaborative, problem solving, creating solutions, tackle real life questions and issues and participate in the creation and amelioration of ideas and knowledge.

In addition, Keselman (2003) as cited by Pedaste et. al (2015) stressed that inquiry-based learning was an educational strategy in which students follow methods and practices similar to those of professional scientists in order to construct knowledge.

Historical background of Inquiry-Based Teaching and Learning

Inquiry- based teaching and learning was very important. This would trace back the beginning of the learning approach. This emerged in the 1960s during the discovery learning movement and relied upon the idea that individuals are able to learn by investigating scenarios and problems and through social experiences. Based on Pappas' (2014) write up teachers encourage the students to conduct investigative works rather than memorizing information from printed materials.

Furthermore, Inquiry-Based Learning has antecedent in ancient Greece and the questioning method employed by Socrates when he was engaging in dialogue with his interlocutors. According to Socrates, the only way he knew was he knew nothing.

As cited by Friesen (2013), Dewey in the early part of the 20th century , newly emerging insights and empirical findings in the learning of sciences suggested that the traditional approaches to education that emphasize the ability to recall disconnected facts and follow prescribed sets of rules and operations should be replaced by "learning that enables the critical thinking, flexible problem solving and the transfer of skills and use of knowledge in new situations"(Darling–Hammond (2008),p.2). Within this frame, rather than learning about a field of knowledge (i.e facts and definitions) or learning elements and pieces of a field (i.e., procedures and rules), Perkins (2009) also cited by Friesen (2013) argued that the students should be given opportunities to "play the whole game) where they can experience junior versions of how knowledge is created and communicated within specific disciplines.

Methodology

Research Design

The study used true experimental and descriptive design. The study used the two comparable classes, the IBT class and the Non- IBT Class. The true experimental design was used to analyze the pre and post test scores of the IBT class and their mean gain scores as well as the mean gain scores of pre and post tests of non-IBT class of grade 7 junior high school students at Talayan National High School with their geometry class. Furthermore, this was used for analysing the difference between the post test scores of the IBT class and the non- IBT class.

The descriptive design was used to determine the perceptions of the respondents with the use, impact and attitude of learners in learning geometry using the IBT approach in teaching.

Locale of the Study

The study was conducted at Talayan National High School which is located beside the national highway. The school is located at Tambunan, Talayan, Maguindanao.This is adjacent to Guindulungan and Datu Anggal Midtimbang Municipalities. The school is also near to Guindulungan National High School.

The school started on 1988. Primarily, it has small number of students. Due to the fast increasing of enrolees, it was decided to find for a more spacious area. The school had few buildings before but presently, it has almost two thousand enrolled students including the Senior high school and students from its three annexes from Tulunan, Datu Kasim and Datu Anggal National High School.

The Respondent of the Study

The subjects of the study were the two comparable sections of grade 7 of Talayan National High School with a total of 149. They were all taking the mathematics subject and they were under Mrs. Morada G. Guiamad. The respondents were all officially enrolled. Majority of the respondents were Maguindanaon.

Sampling Design

Random sampling was used in this study. However, the Analysis of Variance (ANOVA) was used to determine which comparable sections used from the five grade 7 sections. All students included in the comparable sections were taken as respondents of the study. The first class, the IBT class, was given intervention and the other one was the non- IBT class.

Instrumentation

A teacher made test for pre and post test was constructed in gathering the data. This was the first instrument being used in this study. The pre and post tests consisted of 30 items each were mixed of Bloom's Taxonomy such as remembering, understanding, applying, analysing, evaluating and creating questions. Table of specifications (TOS) was constructed and used as basis in making the pre and post tests. The department of Education K to 12 grading system scale was used in describing the score of the respondents in the pre and post tests. Below is the K to 12 grading system scale with its description.

Range	Description
24-30	Outstanding
18-23	Very Satisfactory
12-17	Satisfactory
6-11	Fairly Satisfactory
0-5	Did Not Meet the Expectation

The second instrument being used in the study was the IBT module. The IBT module consisted of the selected topics in geometry, the application of 5Es and the lesson plan. The topics being covered were basic concepts and terms in geometry, angles and polygons. The IBT module consisted of the following parts; Part I- Lesson overview, this lesson overview contained the introduction of the lesson, the objective, the lesson, the relevant of the previous knowledge and the details about the class. Part II- The lesson Plan which gave direction to the lesson. Part III- Teaching hints. This suggested the teaching approaches to teaching lesson. This also gave time limits to perform the task given. Part IV- Used of chalkboard Actual and organized explanation of the core points of the lesson on the board. Part V- English as learning tool was the universal language as a tool to effectively deliver the lessons. The IBT module was validated by the panel members of Mindanao State University- Maguindanao professors. Validation resulted to the "Agree and strongly agree" responses that the Pre and Post test questionnaire, IBT module and survey questionnaire were valid to use for instruction and for gathering data.

The third instrument being used in this study was the questionnaires on the perceptions of grade 7 students of Talayan National High School in learning selected and basic topics in geometry, its impact to students in terms of using IBT, impact to learning geometry and towards the attitudes of the learners. The questionnaires were consisted of 30 items.

The learners' answers to the questionnaires were according to the 4- point Likert scale.

Scale	Verbal Description	Criteria
4	Strongly Agree (SA)	With very high motivation to agree on perception on IBT
3	Agree (A)	With high motivation to agree on perception on IBT
2	Disagree (D)	With low motivation to agree on perception on IBT
1	Strongly Disagree (SD)	With very low motivation to agree on perception on IBT

The verbal description of strongly disagree and disagree means that the perceptions of grade 7 students in learning geometry were not favourable in learning geometry using the IBT approach in teaching. This further implied that IBT has less effect on teaching and learning on selected geometry lessons. Furthermore, it indicated that IBT has also less effect on students' attitudes in learning geometry. On the other side, the learners' responses of "Agree and Strongly agree" manifested that learners are favourable to the IBT approach. Furthermore, this showed that IBT was an effective teaching approach in teaching towards students' learning and improvement in their attitudes in mathematics.

The Likert scale above was used in determining the impact of IBT in learning selected geometry lessons and to the change in attitudes of the learners in learning geometry.

The preliminary draft of the instrument was submitted to the adviser, corrected and given comments. Panel members were also given a copy of the instrument for further validation.

After the retrieval of the instruments, corrections were considered. Final draft was given to the adviser for corrections.

Data Gathering Procedure

The researcher gathered the data through the following:

Letter permission was given to the schools division superintendent and the principal asking for the conduct of the study. Then, pre- test was administered to the two selected sections. The pre- tests of the students were checked and properly documented.

The checked and validated module was used for 15 days teaching the learners. After the modular teaching was done, the

post test was administered. Questionnaires to determine the perception of the respondents towards learning and their attitude in learning geometry using IBT were conducted.

Statistical Treatment of Data

The SPSS or the Statistical Package for Social Sciences was used in the analysis of the data. Frequency, percentage, mean and standard deviation were used to answer statements of the problems one and two specifically the mean gain scores of the IBT and Non-IBT class. Then Multi Analysis of Variance (MANOVA) was used to determine the significant difference of the mean gains of IBT class and the non IBT class.

The descriptive statistics like weighted rank was used in question number 4 of the research such as:

Mean Range	Scale	Verbal Description
3.50- 4.00	4	Strongly Agree (SA)
2.50-3.49	3	Agree (A)
1.50- 2.49	2	Disagree (D)
1.00 - 1.49	1	Strongly Disagree (SD)

Results and Discussion

This chapter presents the tabulated results from gathered data and its corresponding analysis and interpretation. It consists of the following (1) Mean Gain Scores of Inquiry-Based Teaching Class; (2) Mean Gain Scores of Non Inquiry-Based Teaching Class; (3) Comparison of Difference on the Mean Gain Scores of Inquiry-Based Teaching Class and Non Inquiry-Based Teaching Class and (4) Students' Perceptions on the Use, Impact and their Attitudes in learning Grade 7 Geometry using the Inquiry-Based Teaching.

Mean Gain Scores of Inquiry- Based Teaching Class

The frequency distribution of mean gain scores of grade 7 Inquiry-Based Teaching Class in geometry in school year 2019-2020 is presented in Table 1. This table illustrates the frequency and percentage of respondents whose scores are either decreased, no gained and with increased of scores from pre to post- tests.

Table1. Frequency Distribution of Mean gain Scores of Inquiry- Based Teaching Class (N=74)

	Remembering		Understanding		Applying		Analyzing		Evaluating		Creating	
	f	f%	F	f%	f	f%	f	f%	f	f%	f	f%
Decreased	10	13.6	9	12.2	13	17.6	22	29.9	16	21.6	12	16.2
No Gain	21	28.4	21	28.4	17	23.0	12	16.0	12	16.2	15	20.3
Increase	43	58.0	44	59.4	44	59.4	40	54.1	46	62.2	47	63.5
Total	74	100	74	100	74	100	74	100	74	100	74	100

Table 1 shows that there were more students who showed increase from pre to post test scores compared to those who have not gained and have decreased in the Inquiry- Based Teaching Class. This implies that IBT helped improve the respondents. Improvement is also due to IBT modular approach during the intervention. Positive outcome is also brought by IBT's actual, discovery and constructive approach. Teachers' effectiveness and competence also helped the respondent improvements in learning. Such improvement are indicated in *remembering* (f= 43 or 58%), *understanding* (f= 44 or 59%), *applying* (f= 44 or 59.4%), *analyzing* (f= 40 or 54.1 %), *evaluating* (f=46 or 62.2%) and *creating* (f= 47 or 63.5%). The result shows that more than half of the respondents improved their learning in all categories such as remembering, understanding, applying, analyzing, evaluating and creating.

Unfortunately, there were still learners who had not gained (decreased and no gain) from pre to post test performance. Combining the percentage of decreased and no gain are: a) *remembering* (f= 31 or 42%) , b) *understanding* (f= 30 or 40.6%) , c) *Applying* (f= 30 or 40.6%) , d) *Analyzing* (f= 34 or 45.9%), e) *Evaluating* (f= 28 or 37.8%) and finally, c) *creating*(f= 27 or 36.5%). Students' no gain in their pre- test to post- test was brought by their absenteeism, nature of learning lack of interest and others that might affect their learning.

Table 1 further implies that majority of IBT class in geometry have improvements in remembering, understanding, applying, analyzing, evaluating and creating. This is determined by their increase in mean gain scores. Moreover, few decreased and constant performance of the IBT class in geometry is may be brought by students' absenteeism, lack of interest or students' nature and weaknesses in learning the subject.

It is worth notifying that classes made improvements from their pre- test to their post- test for both units but students receiving instruction through inquiry –based instruction showed significantly more improvement on the second unit in the study "Inquiry- Based Mathematics Instruction Versus Traditional Mathematics Instruction: The Effect on Student Understanding and Comprehension in Eight Grade Pre- Algebra Classroom" (Ferguson, 2010).

Mean Gain Scores of Non Inquiry- Based Teaching Class

The frequency distribution of mean gain scores of grade 7 Non Inquiry-Based Teaching Class in geometry in school year 2019-2020 is presented in table 2. This table illustrates the frequency and percentage of respondents whose scores either decreased, no gained, and with increased of scores from pre to post- tests.

Table 2. Frequency Distribution of Mean gain Scores of Non Inquiry- Based Teaching Class (N=75)

	Remembering		Understanding		Applying		Analyzing		Evaluating		Creating	
	f	f%	f	f%	f	f%	f	f%	f	f%	f	f%
Decreased	22	29.4	31	41.4	21	28.0	18	24.0	23	30.6	10	13.3
No Gain	21	28.0	23	30.7	32	42.7	22	29.4	14	18.7	24	32.0
Increase	32	48.6	21	27.9	22	29.3	35	46.6	38	50.7	41	54.7
Total	75	100	75	100	75	100	75	100	75	100	75	100

Based on the result, Table 2 showed that there were small number of respondents who showed increase from pre to post test scores compared to those who have decreased in the Non Inquiry-Based Teaching class. This implies that Non inquiry- Based Teaching or the conventional method of teaching is *"Less Effective"* and contributed little in students' performance in terms of *remembering* (f=32 or 48.6%), *understanding* (f= 21 or 27.9%), *applying* (f= 22 or 29.3%), *analyzing* (f= 35 0r 46.6%), *evaluating* (f= 38 or 50.7%) and *creating* (f= 41 or 54.7%).

On the same table, it was presented that less than half of the respondents improved their learning in categories such as remembering, understanding, applying, analyzing, evaluating and creating.

Moreover, there were more respondents who did not improve (decrease and constant scores) in pre- test and post test in geometry. Combining the frequencies and percentage of decrease and no gain are: a) remembering (f= 43 or 57.4%), b) understanding (f=54 or 72.1%) ,c) applying (f= 53 or 70.7%), d) analyzing (f= 40 or 53.4%) , e) evaluating (f= 37 or 49.3%), f) creating (f= 34 or 45.3%).These clearly imply that Non IBT contributed less on students' learning improvements.

It further showed that majority of Non IBT Class in geometry have not improved (decrease and with constant scores) in their pre-test and post test geometry. Furthermore, there was little increase in the respondents' score in their pre-test and post- test in geometry. This signifies that conventional approach in teaching is less effective than the IBT approach. The constant, decrease and less increase in test scores of the IBT class may fall under students' absenteeism, students' nature of learning and lack of interest. Low performance of the respondents in the Non IBT class were brought by teacher's conventional approach in teaching where the teacher directly gave lectures on the lesson's content to the learners. Consequently learners' knowledge gain is limited only on what the teacher had given them.

Traditional teaching method where teachers do all the actions, give direct instructions and outcome is expected, is no longer arouse the interest of the students. This is the reason why teachers opted to use Inquiry –based approach (Sanches, 2016).

Comparison of Difference on the Mean Gain Scores of Inquiry-Based Teaching Class and Non Inquiry- Based Teaching Class

The Table below presents the comparison between the mean gain scores of the Inquiry- based teaching class in geometry and Non- Inquiry Based Teaching Class. The F values, p- values, interpretation and decision are also illustrated.

Table 3. Comparison of Difference on the Mean Gain Scores of Inquiry- Based Teaching Class and Non Inquiry- Based Teaching Class

Dependent Variable	Class Group	Mean Gain	F- Value	P- value	Interpretation	Decision
Remembering	IBT	0.77	5.474	0.021	Significant	Reject Ho_1
	Non- IBT	0.25				
Understanding	IBT	0.97	33.806	0.000	Significant	Reject Ho_2
	Non- IBT	-0.23				
Applying	IBT	0.97	12.683	0.000	Significant	Reject Ho_3
	Non- IBT	0.07				
Analyzing	IBT	0.69	0.962	0.328	Not Significant	Do not Reject Ho_4
	Non- IBT	0.43				
Evaluating	IBT	0.88	7.077	0.009	Significant	Reject Ho_5
	Non- IBT	0.28				
Creating	IBT	1.28	5.611	0.019	Significant	Reject Ho_6
	Non- IBT	0.72				
OVERALL	IBT	0.92	10.853	0.000	Significant	Reject Ho_7
	Non- IBT	0.25				

As gleaned in Table 3, the mean gain scores difference of IBT class and Non IBT class of grade 7 students in geometry is significant. This implies that IBT "*Significantly Affect"* the learning of the students in grade 7 geometry as indicated in the mean gain difference of overall IBT Class ($\bar{x}$= 0.92) and Non- IBT Class ($\bar{x}$ =0.25 with F- value=10.853 and p-value = 0.000).

Furthermore, Table 3 showed that IBT is better than the conventional approach. There is only one mean difference of mean gained of IBT and Non- IBT class which is not significant but not rejected in the category of analyzing. Insignificant of mean gained scores difference is may be brought by students' absenteeism, lack of interest or students' nature of learning. Significant difference in mean gain is shown in remembering (F-value= 5.474, p-value= 0.021), understanding (F-value= 33.806, p-value= 0.000), Applying (F-value= 12.683, p-value=0.000), Evaluating (F-value= 7.077, p-value= 0.009) and Creating (F-value= 5.611, p-value= 0.019).

The results clearly implied that IBT is an effective approach in teaching and learning of students in geometry as subject focused in this study. This may be true and effective in dealing with other academic fields.

It is worth considering that students who were instructed through inquiry based learning performed very well than those who engaged in a traditional method of teaching in the study "The Effect of Inquiry-Based Learning Method on Students' Academic Achievement in Science Course **(**Abdi, 2014).

Students' Perceptions on the Use of IBT in Geometry

Table 4 presents the rating of inquiry-based teaching class on the students' perception on the use of IBT in geometry.

Table 4. Students' Perceptions on the use of IBT in Geometry

Statements	Mean	SD	Description
IBT…			
1. helps me understand the lessons in geometry	4.00	0.00	Strongly Agree
2. makes me interested in learning geometry .	3.99	0.12	Strongly Agree
3. gives me new concepts in learning geometry.	4.00	0.00	Strongly Agree
4. shows the importance of learning geometry.	3.95	0.23	Strongly Agree
5. shifts my traditional concepts in learning to the new approach.	3.96	0.20	Strongly Agree
6. makes me understand the sharing of ideas .	3.99	0.12	Strongly Agree
7. makes me see the importance of learning by doing.	3.97	0.16	Strongly Agree
Overall	3.98	0.12	Strongly Agree

Table 4 showed that respondents strongly agreed that learning with the use of IBT is helpful and has impact on their learning ($\bar{x}$= 3.98 ; SD= 0.12).

On the same Table, it showed the respondents mean ratings and standard deviation of responses on the use of IBT. The result indicated that IBT has great impact towards the learning of the students. The IBT affects learning by its uniqueness as student centered approach. Furthermore, teachers' teaching style motivates the students to learn more. Their responses were indicated in terms of item number 1- *"IBT helps me understand the lessons in geometry* "($\bar{x}$= 4.00, SD=0.00), item number 2- " *IBT makes me interested in learning geometry"* ($\bar{x}$= 3.99, SD= 0.12), item number 3- *"IBT gives me new concepts in learning geometry"* ($\bar{x}$= 4.00, SD= 0.00), item number 4- *"IBT shows the importance of learning geometry"* ($\bar{x}$= 3.95, SD= 0.23), item number 5- " *IBT shifts my traditional concepts in learning to the new approach"* ($\bar{x}$= 3.96, SD= 0.20), item number 6- "IBT makes me understand the sharing of ideas" ($\bar{x}$= 3.99, SD= 0.12) and item number 7- "*IBT makes me see the importance of learning by doing"* ($\bar{x}$= 3.97, SD= 0.16).

The result implies that the learning of the students in grade 7 geometry is strongly affected by the use of IBT as perceived by the respondents. Moreover, the use of IBT has positive effect on students' learning .

Students' Perceptions on the Impact of IBT in Geometry

Table 5 presents the rating of inquiry-based teaching class on the students' perception on the impact of IBT in geometry.

Table 5. Students' Perceptions on impact of IBT in Geometry

Statements	Mean	SD	Description
IBT…			
1. improves my reasoning ability.	4.00	0.00	Strongly Agree
2. improves my communication skills.	3.97	0.16	Strongly Agree
3. improves my performance in solving Math problems	3.92	0.27	Strongly Agree
4. enjoys me doing activities from the module.	3.91	0.29	Strongly Agree
5. motivates me to learn more about geometry lessons.	3.96	0.20	Strongly Agree
6. develops my questioning ability.	3.99	0.12	Strongly Agree
7. makes me interested in numbers and figures.	3.97	0.16	Strongly Agree
Overall	3.96	0.17	Strongly Agree

Table 5 showed that respondents strongly agree on the impact of IBT in the learning of grade 7 in geometry. This implied that the IBT affects the learning of the students. IBT includes actual or experiential learning that makes the learners interested to learn ($\bar{x}$= 3.96, SD= 0.17).

Table 5 also showed that the IBT class students strongly agreed that using the IBT approach in teaching geometry positively improved their learning. Moreover students got interested in doing the learning activities from the IBT learning module. These responses were indicated by item number 1- "*IBT improves my reasoning ability*" ($\bar{x}$= 4.00, SD=0.00), item number 2-*"IBT improves my communication skills"(* $\bar{x}$= 3.97, SD=0.16), item number *3 " IBT improves my performance in solving Math problems"* ($\bar{x}$=3.92, SD=0.27) item number 4- *" IBT enjoys me doing activities from the module"* ($\bar{x}$= 3.91, SD= 0.29), item number 5- *" IBT motivates me to learn more about geometry lessons"*($\bar{x}$= 3.96, SD= O.20), item number 6- *"IBT develops my questioning ability"(*$\bar{x}$= 3.99, SD= 0.12), item number 7- *" IBT makes me interested in numbers and figures* ($\bar{x}$= 3.97, SD= 0.16).

It further showed that the IBT has a great impact on the learning of the students in grade 7 students in geometry as perceived by the respondents in terms of the items mentioned above.

Students' Attitudes in Learning Geometry Using IBT

Table 6 presents the rating of inquiry-based teaching class on the students' attitudes in learning using IBT in geometry.

Table 6. Students' Attitudes in Learning Geometry Using IBT

Statements	Mean	SD	Description
IBT…			
1. strengthens my study habits.	3.97	0.16	Strongly Agree
2. makes me work cooperatively.	3.96	0.20	Strongly Agree
3. improves my way of interacting others.	3.96	0.20	Strongly Agree
4. makes me learn to respect other ideas not to criticize but tries to make connections.	3.97	0.16	Strongly Agree
5. triggers me to always review my lessons.	3.99	0.12	Strongly Agree
6. encourages me to always do my home works and assignments.	3.97	0.16	Strongly Agree
7. develops my interests in illustrating figures.	4.00	0.00	Strongly Agree
Overall	3.97	0.14	Strongly Agree

Table 6 showed that students strongly agreed that IBT affects students' attitudes in learning. Based on the result, the IBT had changed grade 7 geometry students' attitudes in learning. Students became active and participative ($\bar{x}$= 3.97, SD=0.14).

Table 6 also showed that students' attitudes in learning geometry using IBT were rated strongly agree by the respondents. These further implied that students' attitudes in learning geometry were changed and even improved by the IBT. These were shown by the students' mean and standard deviation in terms of item number 1- *"IBT strengthens my study habits"* ($\bar{x}$= 3.97, SD= 0.16), item number 2- *"IBT makes me work cooperatively"* ($\bar{x}$= 3.96, SD= 0.20) , item number 3- *"IBT improves my way of interacting others"*($\bar{x}$= 3.96, SD= 0.20) ,item number 4- *"IBTmakes me learn to respect other ideas not to criticize but tries to make connections"*($\bar{x}$= 3.97, SD= 0.16), item number 5- *"IBT triggers me to always review my lessons"*($\bar{x}$= 3.99, SD= 0.12), item number 6- *"IBT encourages me to always do my home works and assignments"* ($\bar{x}$= 3.97, SD= 0.16) and item number 7- "*IBT develops my interests in illustrating figures*" ($\bar{x}$= 4.00, SD= 0.00).

Overall result showed that grade 7 students' attitudes in learning geometry were strongly affected by Inquiry-Based Teaching. This strongly changed and improved students' attitudes in learning.

Notably, in comparison of which textbook of grade 8 in Science promoted inquiry- based instruction, findings revealed that teachers showed progress in applying inquiry- based instruction and students became more engaged in learning in the study "Science Teachers' and Students' Perceptions of the Implementation of Inquiry-Based Learning Instruction in a Middle School in Dubai" (Eltanahy and Forawi , 2019).

Findings

Based on the data gathered the following major findings are stated briefly as:

1. Majority of the respondents in IBT class got improvement in their Geometry test scores from pre- test to post test in remembering (43 or 58%), understanding (44 or 59.4%), applying (44 or 59.4%), analyzing (40 or 54.1%), evaluating (46 or 62.2%) and creating (47 or 63.5%).

2. Majority of the respondents in Non- IBT class showed no improvements in their geometry post test in remembering (43 or 57.4%), understanding (54 or 72.1%), applying (53 or 70.7%), analyzing (40 or 53.4%), almost half in evaluating (37 or 49.3%) as well as creating (34 or 45.3 %).

3. There is a significant difference in the mean gain scores between inquiry-based teaching class ($\bar{x}$= 0.92) and non-inquiry based teaching class ($\bar{x}$= 0.25) as indicated in the difference (F- value= 10.853 and p-value= 0.000). IBT is an effective intervention in teaching geometry.

4. Most students strongly agree that Inquiry-based approach in teaching geometry has positive effect in terms of its use, impact and attitudes in learning geometry. Thus IBT effectively improved students' learning and attitudes towards Geometry.

Conclusion

Based on the findings of the study, it is concluded that Inquiry- Based Approach in teaching is an effective intervention in teaching geometry. It improves learners' attitudes in the aspects of remembering, understanding, applying, analyzing, evaluating and creating. Furthermore, IBT has positive effect to students in terms of its use, impact and to the learners' attitudes in learning geometry.

Recommendations

Based on the findings and conclusion of the study, the following are recommended:

1. DepED officials and school administrators should initiate and conduct trainings and seminars on modern approaches in teaching.

2. Teacher shall adopt the Inquiry- Based approach in teaching mathematics for improving teachers' teaching approach, students' learning and attitudes.

3. Other teachers should modify, improve and use the researcher's IBT module in their own class.

4. Researchers may conduct further related research on the impact of Inquiry- Based Teaching in other subjects.

5. Future researchers may conduct researches on the use of IBT compared to other strategy in teaching Mathematics.

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