Research Article

Differentiated Instruction through Tiered Activities in Teaching Geometry to the Junior High School students

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Abstract: A study of differentiated instruction through tiered activities in teaching Geometry was conducted using a quasi-experimental method with pre-post-tests control group design to measure the effectiveness of differentiated instruction in teaching geometry. Formed two intact groups, and seventy-six (76) Junior high school students were selected as respondents of the study. Thirty-eight (38) belong to the control group, and the remaining thirty-eight (38) belong to the experimental. Students in experimental were exposed to different strategies in differentiated instruction through tiered activities in which the degree of complexity or abstractedness differs. On the other hand, students in the control group were exposed to traditional instructions. The findings revealed that the overall performance of the experimental group is above the 75% level of criterion. It is also revealed a significant increase in the performance of the experimental and control groups from pre-test to post-test. It is concluded that traditional and differentiated instruction are both effective approaches in the teaching and learning process, and teachers should use various teaching approaches to address todays' diverse learners. Moreover, it is suggested not to use a single strategy, method, approach, or technique in delivering instruction to address the need of todays' mixed-ability classroom. It is recommended to include differentiated instruction as approach in the In-Service Training of the teachers and conduct a series of seminars on the different elements of this approach to have a deeper understanding and have a better idea of how to use it to determine its actual effect on students' achievement.

Keywords: Differentiated instruction, Diverse learners, Quasi-experimental design, Readiness, Tiered Activities

1. Introduction

Teachers struggle every day to provide quality instruction to their students in the classroom across all academic subjects (Tomlinson & Mc Tighe, 2006). One of the academic subjects in which teachers find it hard to deliver their instruction in Mathematics. Considering mathematical knowledge is an essential tool for survival in this fast-growing and ever-changing society. Mathematical knowledge is crucial to educational success and financial success, especially in contemporary society, and is becoming ever more so. Thus, every child must acquire and develop his/her mathematical skills (Siegler, 2012).

Unfortunately, mathematical teaching and learning have been a perennial challenge in the Philippine educational curriculum and other countries. It is evident in the results of the different international, and national assessments in Mathematics, such as Trends in International Science and Mathematics Study (TIMMS) (2011) reported that the mathematics performance of the ten (10) participating countries in ASIA PACIFIC is declining.

On the other hand, Program International Students Assessments (PISA) (2018) reported that the ability of the Filipino student in mathematics is classified as below level 1 proficiency, and this performance is below the expected target. In the Philippines, the department of education, Region 2, issued a regional memorandum dated May 24, 2019, the results and analysis of the National Achievement Test for grades 6, 10 and 12 conducted year 2018. It shows that students' mathematical problem-solving skills performance is second to the last among five core subjects. Moreover, the results of the different examinations conducted by the Department of Education, particularly in the division and regional offices, such as division achievement test (DAT), regional achievement test (RAT), showed that the Mean Percentage Score (MPS) in mathematics is very low, this is 2nd to last among the core subjects.

Hence, it prompted the government and academic officials to conduct a thorough study and investigation regarding the plans, programs, and development of mathematics curriculum in the country, both in the elementary and secondary schools, may it public and private institutions. With these, the government allocated a huge budget for the training, seminars, and research for the teachers and educators to improve mathematics instruction in the country.

The complexities and diversities of todays' classrooms are significant factors to consider to ensure the maximum learning competencies of the students. According to Tomlinson (2003), ignoring the diversity of the learners who occupied the classroom is increasingly difficult for teachers. To cope with this diversity, teachers

need to adapt their teaching, which means they have to arrange the environmental conditions of teaching that fit learners' differences (Smit & Humpert, 2012).

The Philippines public school classrooms are congested with forty-five (45) to fifty (50) students. Moreover, most of the public and private schools in the country are now adopting inclusive education. It means education for all regardless of the physical and mental ability of the school children. These students have many differences, maybe not really in culture but in learning abilities, physical abilities, and modalities of learning across all academic subjects, particularly in Mathematics. Thus, it becomes a more significant challenge to respond to the needs of every student in a diverse classroom. Taking in to consideration also the budgeted topics and competencies covered in a particular grading period/quarter and the need to cope with other standards set by the Department of Education. Bearing in mind, the students do the same assessment activities, and at the end of the quarter/semester, they will take the same set of tests or answer the same set of questions. The results are compared to the other subjects. Test results are also compared with the other schools, divisions, and regional offices. They are ranked according to the mean percentage score (MPS).

To deal with the challenges, teachers usually focus on the average students or teach in the middle and use a single strategy with tasks of the same level of difficulty or abstractedness, thinking that it would be the best way to handle the situations but results are still frustrating and disgusting. The struggling learners continue to face the hurdle in acquiring mathematical skills, while advanced learners are underdeveloped.

According to Tomlinson and Tigher (2006), two of the leading proponents of differentiated instruction said, fair does not mean that everyone receives the same yet; it means that everyone gets what he/she needs. Hence, differentiated instruction through content readiness using tiered activities in teaching geometry could be a possible response for all of these. The level of readiness of the students pertains to his/her knowledge, understanding, and skill related to a particular sequence of learning. His/her prior learning, experiences in life, and attitude about school as students' cognitive proficiency influences it. Yet, readiness levels widely vary over time according to topic and circumstances (Corley, n.d.). As Tomlinson (2003) points out, if readiness levels in a class vary, so must the complexity of the provided tasks. Tiered activities are one way to address readiness effectively so all students study the same concept but complete activities appropriate to their readiness levels.

Relevant literature

Differentiated instruction is an educational approach that adjusts instruction to accommodate individual student needs rather than beginning at a predetermined set point. Unlike in the traditional instruction who tends to "teach at the middle" or primarily focus on reaching average learners yet, it seldom addresses the needs of struggling and advance learners in the classroom. Additionally, according to Liu (2006), differentiated instruction is a teaching-learning philosophy whose primary focus is enabling learners to be successful through the designed instruction.

According to Ann Logsdon, a school psychologist, differentiated instruction is modifying and adapting instruction, materials, content, student projects, and products, and assessment to meet student learning needs. In a differentiated classroom, teachers recognize that all students are different and require varied teaching methods. In contrast, traditional instruction is historically fixed and inflexible.

Related Studies

Alavinia, P. & Farhady, S. (2012) investigated the effects of differentiated instruction to teach vocabulary in mixed ability classes with a focus on multiple intelligences and learning styles; results show a significant amount of difference between the performances of different learners with various intelligence and learning style.

Yet, it contradicts the finding of Landrum & McDuffie (2010), Wilson (2011), and Malacapay (2019); they pointed out that there is no relationship between the learning styles of the students and academic achievement. Another study of differentiated instruction is by Wilson (2011), he examined the relationship between students' level of academic achievement and students' learning styles matched to the instructional strategies incorporated by their teachers. The findings show a lack of solid possible relationship between the learning style preference of the fourth grade and instructional approaches of the teacher and the academic achievement.

On the other hand, Goddard et al. (2015) investigated the relationship between school instructional climate and students' fifth-grade mathematics and reading achievement. Findings inform a positive and significant relationship between the school norms for teaching practices consistent with differentiating instruction to mathematics and reading achievement.

Adodo & Agbayewa's (2011) investigated the effects of homogeneous ability level grouping and heterogeneous ability class teaching on students" learning outcomes. They examined how to best give the low achievers in science the extra help they need without reducing the interest and progress of the high achievers. It

was found out in the study that homogeneous grouping is more effective for fostering students learning outcomes and for boosting their interest in learning.

Shepherd (2015) studied technological devices in teaching deaf learners; results positively affect on the students. It makes them more interested and actively engaged in-class activities and discussions. It also provides a higher level of retention compared to the traditional way. On the other hand, Scott (2012) also examined the effects of gender and aptitude of average and above-average students using differentiated instruction in elementary mathematics. Still, the results show there was no significant difference in their mathematics performance.

This study aimed to determine the effectiveness of differentiated instruction in teaching geometry to Junior high school students. Specifically, it sought to answer the following questions:

1. What is the post-test geometry performance of the students in the control group and the experimental group?

2. Is there a significant mean difference in the post-test performance of the students between the control and experimental groups?

3. Is there a significant mean gain of the students' performance in geometry from pre- to post-tests in the:

3.1. Control Group:

3.2. Experimental Group?

2. Materials and Methods

This chapter described the planning episode of this research study. It is comprised of a thorough discussion on the research design, research participants, sampling design, and the research environment.

Ethical Consideration

The ethical consideration of the study is based on the Belmont Report of 1974 which has three basic ethical principles in research which involved humans as subject, including respect for persons, beneficence, and justice.

To preserve and protect the ethical standards in conducting research, the researcher called for a conference for all participants. Discussed with them the rationale of the study and disclosed the information regarding the research under investigation. It includes presenting research information to the respondents, such as the content and basis of conducting the study and why they are chosen as participants. Moreover, I informed them that withdrawal from the participation of the study at any time is possible, and participation is voluntary. Besides, if they did not feel like responding to any of the particular questions or participating the activity, they had the right to say so. It guaranteed them that any information they revealed is treated with high respect and confidentially.

Moreover, participants are given an assurance that anything they want to know about the results/findings of the study is provided to them. Ample time is given to consider or decide whether to take part/not in the study. Provided informed consent to each of them containing the potential risk and benefits of the study, contact persons in emergency cases, the extent of how the data will be kept confidential.

Research Design

This study was a quasi-experimental method with the pre-post-test model with a control group design that sought to investigate differentiated instruction in teaching geometry to the junior high schools in a public high school in Cebu, Philippines. The two groups were assigned as intact because the respondents were not randomly assigned to the condition. The intact classes were two junior high school classes taking Geometry subject, yet the school principal and class advisers randomly selected the students at the beginning of the school year. This study was conducted in a small public high school in the province of Cebu, Philippines.

Sampling Techniques/Sampling Frame

The purpose of sampling is to identify the best possible representation among the target population under investigation. In this case, all seventy-six (76) junior high school students enrolled in the geometry class were chosen as study respondents. The students of each class/section were constructed/formed randomly by the school administrator and class advisers at the beginning of the year. Thus, it is used to determine the equivalent intact group of the students.

Instruments

This used the teacher-made test in Geometry to measure the conceptual understanding of the students. To test the instruments' reliability, the Cronbachs' Alpha was used with a reliability coefficient of 0.710, using the SPSS Statistical Data Analysis.

The questions were based on the table of specifications that measured the skills of remembering, understanding, applying, analyzing, evaluating, and synthesizing with the criterion of 75% and distributed as follows: 60 percent comprised easy questions, 30 percent average, and 10 percent difficult questions. This is based on DepEd order No. 79, s; 2003 (Assessment and Evaluation of learning and reporting of student progress in Public Elementary and Secondary schools). These questions were also congruent to the topics for the 3rd and 4th grading periods, namely, Triangle congruence, quadrilateral, similarity, special right triangle, circles, and the coordinate plane. It is a fifty-item test and designed to be answered for 60 minutes as the official time in mathematics class for high school. The competencies, skills and concepts were given by the department of education for the mathematics curriculum in geometry.

The test served as the general pre-post-tests tool for the respondents to determine the effectiveness of differentiated instruction in teaching geometry. It includes the table of specifications for the examination and other instruments by which the researcher utilized were the teaching plans, activity sheets /work. These materials usually contained the title, objectives, competencies, and the instructions to be followed, which drawings, graphs, and illustrations may accompany. These instruments were also designed to process mathematics. It helps determine the students' degree of competence in applying the mathematical processes and skills to a situation involving experimentation, making an observation, identifying patterns, manipulation, and problem-solving.

Data Gathering Procedure

A pilot test of the researcher-made test was conducted on selected senior high school students for the validity and reliability of the research tool. Revisions have been made on some items before the final administration of the instrument. Then pre-test was given to both groups of students before the study was formally started.

The control group was exposed to the traditional instruction. It was taught using a conventional approach where lessons and activities were presented through a single strategy for all or a one-size-fits all strategy regardless of their level of ability. On the other hand, the experimental group was exposed to differentiated instruction. A sufficient mode of instruction was given to them using differentiated instruction to readiness level of abilities to develop mathematical concepts and ideas.

The activities of this study were based on the readiness levels of thinking through tiered activities in which questions and tasks differed in the degree of complexity and abstractedness and were formulated based on Benjamin Bloom's taxonomy domains of thinking. Additionally, most of the activities were done through groupings from a larger group to small group until individual activities or tasks so that students would develop their full potentials and work independently.

These students focused and developed the same essential contents, skills, and competencies. Moreover, most of the activities were done through cooperative learning. After doing its respective tasks each group was required to present their output to the whole class for sharing and further discussions. This was also done to give chance to the other groups to familiarize themselves and learn related tasks. The teacher is also expected to give additional input about the topic being developed and explained carefully to the entire group about the idea being emphasized.

The respondents were classified as learners who need more attention, average learners, and advanced learners. It is done before beginning the instruction through informal assessment. Still, the students were placed in a temporary group depending on their performance in a particular topic and or in a particular grading period. They may transfer from one group to another to avoid labeling, which could create negative impressions and demoralize the less able learners. After the administration, both the control and experimental groups were subjected to post-test, and test results from both groups were compared and analyzed to determine if a significant difference exists or otherwise.

4. Data Analysis

After all the data were collated, gathered, and organized, it was analyzed using descriptive and inferential statistics for quantitative analysis and after which presented findings. findings. The statistical package for social science (SPSS) was used for data analysis. Used a simple percentage relative to 75% level of criterion to determine the students' performance in geometry. On the other hand, to determine if there was a significant increase from pre- to post-test, the t-test of pre-post-test mean gain was used. In contrast, a t-test of paired/independent samples was used to determine significant differences between the performance of the control and experimental groups in geometry.

5. Results

Table 1: Posttest level of Performance per topic of the Control and Experimental Groups.

	Post-Test

Variable	N	Actual Mean	Hypothetical Mean	Description
Control Group				
Triangle Congruence	38	4.24	3.75	Above 75% level of criterion
Quadrilateral	38	6.47	6.00	Above 75%blevel of criterion
Similarity	38	9.11	8.25	Above 75% level of criterion
Special Right Triangle	38	3.63	3.75	Below 75% level of criterion
Circles	38	7.92	9.00	Below 75% level of criterion
Coordinate Plane	38	5.39	6.75	Below 75% level criterion
Overall	38	36.76	37.50	Below 75% level of criterion
Experimental Group				
Triangle Congruence	38	4.29	3.75	Above 75% level of criterion
Quadrilateral	38	7.10	6.00	Above 75% level of criterion
Similarity	38	9.63	8.25	Above 75% level of criterion
Special Right Triangle	38	4.11	3.75	Above 75% level of criterion
Circles	38	9.10	9.00	Below 75% level of criterion
Coordinate Plane	38	6.80	6.75	Above 75% level of criterion
Overall	38	39.17	37.50	Above level of criterion

Table 1 above presents the post-test level of performance of the students in geometry relative to the 75% level of criterion set by the department of education. It shows that the overall actual mean of the control group is below the expected mean, which is set to 37.50. On the other hand, the experimental group got 39.17 which is above the hypothetical mean. It also shows that in most of the topics and competencies being measured, the experimental groups' level of performance is better than that of the traditional group, as reflected in the table. Hence, the post-test level of performance of the experimental group relative to the level of criterion is better than the other group as it was categorized as above level of criterion. As a whole, the experimental group obtained above the set passing score in the examination.

Table 2: Difference of the Posttest Performance of the Control and Experimental Groups

Group	N	Actual Mean	SD	t- Value	P=Value
Control	38	36.74	5.41		
Experimental	38	39.17	5.61	-1.91	0.059

Table 2 above presents that the mean of the experimental group is higher than of their counterpart. However, the p value of 0.059 is greater than the .05 level of significance. It also shows that the experimental group's standard deviation is 5.91, which is higher than the control group. These findings suggest that their mean difference was not enough to warrant/guarantee that one approach is better than the other. In other words, the difference of their mean has no bearing/no significant difference in their performance. It also suggests that the scores of the experimental group are more scattered/spread than the control group. Thus, both approaches have their effects on the performance of the students.

Table 3: Pre- Post Test Mean gain of the Control Group

Grouping variables	N	Mean	SD	Mean Gain	T- Value	Alpha	P- Value
Pretest	38	18.74	4.67				
Posttest	38	36.74	5.41	18	16.190	0.05	0.000

Table 4: Pre- Post Tests Mean Gain of the Experimental Group

Grouping variables	N	Mean	SD	Mean Gain	T- Value	Alpha	P- Value
Pretest	38	19.55	4.61				
Posttest	38	39.16	5.61	19.61	16.90	0.05	0.000

Table 3 & 4 above reveals that the pre-post-tests performance of the control group and experimental group is much higher than their performance in the pre-test which signifies that both groups of students performed better in the post-test. Moreover, it also shows the alpha value of a 0.05 level of significance is greater than the p value equal to 0.00. The result suggests that there was a very high increase in the performance and the improvement is highly substantial. It means the increase is not due to chance, and these could be attributed to the two approaches of learning used in the classroom. Thus, both approaches are effective modes in the delivery of instruction.

6. Discussion

The academe and education sectors worldwide had never stop searching solutions to best address the students' mathematical ability and diversities of today's classroom. Hence, they have tried different approaches in teaching and learning, including differentiating the instruction.

The findings of this study revealed no significant difference between the performance of the traditional and differentiated instruction. It is also shown that both have shown a significant increase from their post-test performance. It implies that both are proven effective approaches in teaching.

Yet, it is pretty interesting to focus the discussion of the findings to the 75% level of criterion as the passing performance as set by the department of education. The passing percentage is too high and very difficult to obtain by the students of the two groups. However, it is noticeable that students using differentiated instruction as an approach of teaching gained better achievement as reflected in their overall performance in the post-test, which is above the criterion level. Moreover, the mean gain difference of their performance is also higher, as shown in the results. Though this is not a guarantee that every student obtained the desired level of performance as reflected in the groups' standard deviation, which is slightly higher, it means their scores are scattered.

Most importantly, it informs us that differentiated instruction really helps improve the level of geometry achievement of the students and helps enhance their ability to acquire mathematical skills. These findings support the report of Sherman (2008), which revealed that those students who were exposed in differentiated instruction obtained bigger mean gains, but it is not shown that everyone achieve mastery of the competencies tested. It also supports Chamberlin & Powers (2010) study that students receiving differentiated instruction produced a higher mean gain in mathematical understanding. It also concurs with the results of Muthomi & Mbugua (2014) study that differentiated instruction enhance students' achievement and led to higher achievement levels in secondary mathematics. It also confirms the study of Ocampo (2018) that differentiated instruction helps improve the reading comprehension level of grade-11 senior high school students. It also reinforces the findings of Chen J. & Chen Y. (2017) that differentiated instruction improved college students' mathematical achievement and learning motivation, and improved teaching efficiency, specifically in calculus. The findings congruent with the results of Ellis, D., Ellis, K. & Huemann, L. (2007) that differentiated instruction produced positive change in student performance and suggested effective in some way. However, these findings contradict the results of Pablico (2017) study that differentiated instruction has no significant effect on students' learning outcomes. It also opposes the findings of Kotob, M. & Arnouss, D. (2019) study that differentiated instruction has no positive effect on achievement of kindergarten classroom.

Another interesting observation of the study is the attitude and behavior of the students during group activities. Since the study employs flexible groupings, there were frequent changes of group members depending on the outcome or performance of the students on the informal assessment. They are grouped group according to their level of readiness in a particular topic. With these, they are motivated and more engaged to do the tasks with confidence and high morale in sharing their ideas with others and eventually developing positive attitudes and a sense of belongingness. The observation is in line with that of Rytivaara (2011) that flexible grouping helps

increase the positive experiences of the teachers and students and eventually help decrease the need for segregated educational settings. Thus, they become more active and participative in the different activities in the classroom.

7. Conclusion

Educators keep on searching for best practices that can help improve the academic performance of the school children in the country, especially in the international assessment. Yet re-engineering and re-directing teaching approaches to cater to todays' diverse learners is always a challenge and responsibility of every teacher. Though traditional instruction is still proven to be useful, differentiated instruction as an approach should be given full consideration as it provides positive outcomes to help improve the students' mathematical achievement and help develop positive attitude of the students in a diverse classroom. It is concluded not to use a single strategy, method, approach, or technique in delivering instruction to address the need of todays' mixed-ability classroom.

Moreover, it is recommended to include differentiated instruction as approach in the In-Service Training of the teachers and conduct a series of seminars on the different elements of this approach to have a deeper understanding and have a better idea of how to use it to determine its effectiveness actual effect on students' achievement

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