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Original Paper

Differentiating Instruction in a Mathematics Classroom: Its Effects on Basic 7 Learners' Academic Performance and Engagement in Common Fraction

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Abstract

Differentiated instruction is a method that can be utilised to help learners with different characteristics master mathematics in every area covered. In this paper, a pre-test and post-test quasi-experiment design was used. The participants in this study were 83 students chosen at random from basic 7. This includes 41 students in the experimental group and 42 students in the control group at St Andrew's Junior High School in Wa, Ghana's Upper West Region. The learners were thoroughly matched based on their learning styles and numerous intelligences. The pre-test was used to assess learners' academic performance prior to the intervention, and the post-test was used to see if there was a difference in the effect of differentiated instruction versus non-differentiated instruction between the control and experimental groups. The study looked into common fractions, specifically converting improper fractions to common fractions, converting mixed fractions to improper fractions, and solving problems requiring fraction addition and subtraction. According to the findings of the study, learners in the experimental group had interactive, analytic, and introspective learning styles. The experimental group has (differentiated class) and the control group's (non-differentiated class) pre-test mathematical achievement was comparable to "low", however, their critical thinking skills were "unreflective". Post-test results, on the other hand, show that the experimental group (differentiated class) has "high" mathematics achievement and "developing" critical thinking skills, whereas the control group

(non-differentiated class) has "average" post-test mathematics achievement and "developed" critical thinking skills. The experimental group outperformed the control group in terms of pre-test and post-test mean improvements in mathematics achievement and critical thinking skills. As a result, the article recommended that practitioners understand the components of differentiation in order to develop lessons that meet the requirements of all learners. Mathematics facilitators must attend workshops and seminars on a regular basis to keep their knowledge and abilities in differentiated instruction up to date.

Keywords

Differentiated Instruction, fractions, facilitators, learners experimental, control

1. Introduction

In this century, facilitators are urged to use diversified instruction approaches in the classroom to accommodate the varying requirements of all learners from various cultural and social backgrounds. Differentiated instruction is a practice that focuses on learners and seeks to reduce inequities and discrepancies between individuals due to their diverse learning styles, abilities, and skills (Chamberlin & Powers, 2010). Differentiated instruction is a teaching technique that implies each classroom has a diverse set of students who may be reached via a range of methods and activities. Differentiated instruction detects individual students' requirements and adjusts the classroom to fit those needs. No two students are alike because they learn at different rates. Based on this notion, variable instruction is a teaching and learning strategy that gives students with a range of ways to absorb knowledge and make sense of topics. Differentiated instruction is founded on the premise that educational approaches in the classroom should alter and adapt to the needs of individual and diverse students. Instead of expecting students to adapt to the curriculum, differentiated instruction demands teachers to be flexible in their approach to teaching and to modify the curriculum and presentation of content to learners (Tomlinson, 2013). The implementation of the basic curriculum in Ghana to improve junior high school mathematics learning and the investigation by Muthoni and Mbugua (2014) on the effects of differentiated instruction on student's achievement in mathematics revealed that differentiated instruction significantly improved students' achievement in mathematics when compared to traditional instruction.

Differentiated instruction has existed for quite some time. Facilitators have to think outside the box in order to satisfy the requirements of all learners, regardless of age or aptitude. Differentiated instruction allows facilitators to draw on best practices to reach all learners. To improve learning in mixed-ability classrooms, this approach employs grouping strategies, brain-based learning methodologies, and current research on multiple intelligences.

Facilitating fractions with differentiated instruction at the fundamental level can make a significant difference. Some students struggle to understand fraction concepts such as equivalent fractions, comparing fractions, mixed numbers, and adding fractions. This could be due to a few inadequacies in their fundamental understanding of fractions in general. Allow these students to study content from prior stages in order to get a better knowledge of fractions as parts of a whole and fractions as parts of a group. While the high-achieving students in class frequently complete third-grade fraction tasks quickly, they begin to show signs of boredom if they are not appropriately challenged. Allow these types of learners to participate in lesson extension activities and study more complex fraction ideas to differentiate instruction.

1.1 Problem Statement

Several studies investigated differentiated mathematics instruction. Numerous research has been conducted to evaluate the effects of differentiated education on academic achievement and other characteristics. Significant disparities in outcomes were discovered (Aranda & Zamora, 2016; Muthomi & Mbugua, 2014; Konstantinou-Katzi et al., 2013; Lewis, 2013; Stager, 2007). The majority of studies discovered that modifying instruction based on learning needs, scaffolding, and flexible grouping resulted in improved performance among learners (Williams, 2012; Thorton, 2012; McAdamis, 2001). Recent research has also demonstrated the effectiveness of using tailored instruction in the mathematics classroom. According to Awofala and Lawani (2020), differentiated instruction improves pupils' maths achievement. Differentiated instruction increases student motivation and involvement (Hapsari, Darhim & Dahlan, 2018). Professional development for teachers in differentiated instruction in the mathematics classroom improved students' achievement (Prast, Van de Weijer-Bergsma, Kroesbergen & Van Luit, 2018). Ismajli and Imami-Morina (2018) demonstrated that differentiated education is successful when teachers use interactive tactics to suit the requirements of all pupils.

Despite the fact that the 2019 Ghana curriculum embraced the use of differentiated instruction in the mathematics classroom to improve learning at the basic level, some studies pointed out barriers and constraints such as insufficient training, support, and resources to be overcome in order to provide opportunities for learners to have differentiated lessons (King, 2010; Lange, 2009; Grey, 2008; Huss-Keeler & Brown, 2007). The curriculum aims to increase mathematics facilitation through spiral progression, in which learners are permitted to study topics and skills that are relevant to their own learning styles, resulting in good retention and mastery of mathematical content. This advancement is supposed to produce critical problem solvers, innovative, creative citizens, and educated decision-makers. Improvement of learners' low performance in common fractions remains a difficulty for facilitators at Ancilla School, since students' performance in that area remains very bad from their exercise, homework, assignment, and class test, as well as personal observation. Facilitators must be equipped with a variety of facilitating tactics and approaches in order to improve learners' learning outcomes and, as a result, increase their performance in Mathematics (Gaylo & Dales, 2017). Against this backdrop, the researcher undertook a study to further evaluate the impacts of tailored instruction on

the performance of basic 7 learners in common fractions. The purpose of this study is to go deeper into the practical implementation of differentiated teaching and compare learners' performance in understanding common fraction courses to the traditional technique.

1.2 Research Question

What is the difference in mathematics achievement in learners who have received differentiated instruction in common fractions as compared to learners who received traditional instruction?

1.3 Significance of the Study

The curriculum in schools has become standards-based, which means all learners are expected to achieve equally and meet high standards despite their varied abilities. Educators are therefore challenged to meet the diverse needs of the learner populations. The only way to meet the objective of the standards-based curriculum is to personalize or differentiate the instruction. Educators must face the challenges of changing from traditional lecture-style instruction to instructional methods that meet the diverse needs of their learners. Differentiated instruction is believed to be an effective instructional strategy because it advocates beginning where individuals are rather than with a prescribed plan of action, that disregards learner readiness, interest, and learning profile. This study is significant and contributes to the existing research because it provides educational leaders with a comparative study of differentiated instruction and traditional instruction. Society has become more diverse and complex, which is also represented in our classrooms. Schools need to adopt learning strategies that enable all learners to meet high standards.

2. Method

2.1 Research Design

The study employed a quasi-experimental pre-test-post-test design. In the second term of the 2022/2023 academic year calendar, the design made use of the basic 7 classes of Ancilla Catholic School, namely basic 7A and basic 7B. The basic 7B class was randomly allocated as the experimental group to receive differentiated instruction. While the basic 7A class was the control group, it was taught using conventional instruction, not differentiated instruction. Both classes were given a pre-test on fractions prior to the study's implementation and a post-test after the study's implementation in the convectional facilitating and differentiated instruction in facilitating fractions. Both Lessons focused on the subtopics of converting improper fractions to mixed fractions, converting mixed fractions to improper fractions, and solving problems involving common fraction addition and subtraction. Based on the requirement assessment and the researcher's observations, the topic of common fractions presented several obstacles to learners. A Task Analysis Matrix (TAM) created by the researcher supervised the preparation of differentiated lessons. Based on the Basic 7 curriculum, these included topics, concepts, instructional objectives, procedural activities for customised instruction, skills, assessment, and references.

2.2 Participants

Thirty-four (34) out of the thirty-five (35) of the learners in the convectional class were present and all the thirty-five learners in the experimental class were present. All learners were used for the study and were however considered in the analysis of data. The town classes were considered to be part of the study because they were those classes considered the poor performing classes in understanding the concept of fractions. For instance, the researcher happens to be a part-time teacher in the school and was teaching those classes.

2.3 Data Collection Procedures

The researchers contacted the headmistress of the Ancilla School, Wa to discuss with her all the details of the study and to seek permission to use the basic 7 class (A and B) for the study in the second term of the 2022/2023 academic year calendar. The study gathered the participants/ learners in each class and codes were assigned to each participant/learner to ensure confidentiality. The basic 7A participant/learners' codes range from A01 to A43 while basic 7B codes range from B01 to B44. Basic 7B class was assigned randomly as the experimental group using differentiated instruction method in teaching fractions while the basic 7A class was the control group taught using the traditional method of instruction. Before the conduct of the study, both classes were given a pre-test on fractions and later a post-test after the implementation of the study in traditional teaching and differentiated instruction. After the pre-test and the post-test an interval of 10 weeks period between the administration of the test. The researchers recorded all test scores on a spreadsheet using the designated codes for the participants/learners. A pre-test and post-test were administered to determine learners' abilities to solve problems involving fractions. Both Lessons were developed on the sub-topics of converting improper fractions to mixed fractions, changing mixed fractions to an improper fraction, and solving problems on addition and subtraction of common fractions. The test items were composed of 40 multiple choice and 4 theoretical questions based on the learning core competencies proposed by the basic 7 curriculum. The same test was administered to the experimental group and the control group. The pre- and post-tests identified learners' strengths and weaknesses before and after the intervention. The post-test provided a measure of what the learners had learned. The materials for the study consisted of the basic 7 mathematics textbooks, mathematics curriculum, and the excellence series that were published in line with the standards of the Ghanaian curriculum for the control group while the group receiving differentiated instruction also used the same mathematics textbooks, mathematics curriculum and the excellence series, manipulatives, laptops, games, and activities.

2.3.1 Data Analysis

The data collected for this study was to determine if learners taught using differentiated instruction methods are different in terms of their mathematics achievement than learners taught using traditional methods of teaching. At the end of the intervention, the post-test that is similar to the pretest was conducted for both groups. The 40-item multiple choice researcher-made performance test is made up of every correct answer one (1) point making for a total of 40 marks and the 4 theory questions are

made up of 15 makes each making a total of 60 marks. The total score for the entire test was 100 marks based on the standards of the new curriculum (National Council for Curriculum and Assessment (NaCCA), 2019). The scores of the learners were presented using raw scores, percentages, and grades, which are in line with the standards as proposed by the basic 7 mathematics curriculum.

2.4 Validity and Reliability

The learning styles of the learners were considered in the development of the lessons. After the development of the lesson experts in the area of mathematics and education (Mathematics coordinator in the municipality, CISOs, and some Lecturers) validated the lesson before the conduct of the study. These were experts on content, pedagogy, and technicalities and evaluated the content and content accuracy, clarity, and appropriateness of the lessons. The research instruments utilized in the study were validated researcher-made performance tests. The academic performance test was crafted to assess the academic performance of learners in common fractions and was tried out for validity and reliability purposes. The test items were composed of 40 multiple choice and 4 theoretical questions based on the learning competencies proposed by the Basic 7 Curriculum. The same test was administered to the experimental group and the control group.

3. Results

3.1 Academic Performance of Learners in the Pre-test

Table 1 below displayed the academic performance of learners based on the scores they obtained from the pre-test administered by the researcher on changing mixed fraction to improper fraction, changing improper fraction to mixed fraction, and addition and subtraction of common fraction. The table displayed scores, number of learners, and percentages of learners in both the experimental group and the control groups in the pre-test. The sample of the experimental group was 42 and that of the control group was 41.

Table 1. Pre-test Scores of the Experimental and the Control Groups

		Experimental Group			Control group	
Performances	**Grades**	**Score (100)**	**No. of learners**	**Percentage**	**No. of learners**	**Perc. (%)**
Highest	1	90-100	0	0	0	0
Higher	2	80-89	0	0	0	0
High	3	70-79	0	0	0	0
High Average	4	60-69	1	2.4	2	4.8
Average	5	55-60	5	11.9	4	9.8
Low average	6	50-54	2	4.8	1	2.4
Low	7	40-49	7	16.7	10	24.4
Lower	8	35-39	13	31.0	12	29.3
Lowest	9	0-34	14	33.3	11	26.8
		Total	42	100	41	100

Source: Scores of learners (2023).

From Table 1, the pre-test results show that the learners in both experimental and control groups had weak scores and were initially at par. It revealed further that learners in both groups did not meet established expectations with the topic considering the result displayed. For example, learners in both experimental and control groups could not score (90-100) the highest in the pre-test. Also, no (0%) score (80-89) was higher in both classes. Again no (0%) could score (70-79) high marks in both classes. While only 1 (2.4%) in the experimental class and 2 (4.8%) in the control class scored (60-69) high average. The score of (55-59) average saw a few 5 (11.9%) of the experimental group and a few 4 (9.8%) of the control group. Again, the table indicated only 2 (4.8%) of the experimental group and 1 (2.4%) of the control score (50-54) low average in the test. The score of (40-49) low average saw 7 (16.7%) of the experiment group and 10 (24.4%) of the control group. While the score of (35-39) lower performance saw more 13 (31.0%) in the experimental group and 12 (29.3) in the control group and the score of (0-34) lowest saw many 14 (33.3%) of the experimental group and 11 (26.8%) of the control group. The results above indicated that before the intervention processes both the experimental group and the control group saw more than 70% of the learners scoring below average even though the scores of the learners in the experimental group were slightly different as compared with that of the control group in the pre-test results. The results indicated that both the experimental and control group were comparable in terms of performance before the intervention. The pre-test scores of the learners in the control group were almost the same. They weren't a significant difference in the learner's performance before that intervention. The results further indicated that learners never got good facilitating at the

initial stage and this suggests that proper pedagogical strategies used could increase learners' performance academically in mathematics. Learners will continue to perform poorly in their studies if the right pedagogical strategies are not used in the mathematics classroom.

3.2 Post-test Scores of the Experimental and the Control Groups

Table 2 below displayed the academic performance of learners based on the scores they obtained from the post-test administered by the researcher on changing mixed fraction to improper fraction, changing improper fraction to mixed fraction, and addition and subtraction of common fraction. The table displayed the frequency and percentages of learners' scores in both the experimental group and the control groups in the pre-test. The participants of the experimental group were 40 out of 42 and that of the control group was 41 out of 41.

Table 2. Post-test Scores of the Experimental and the Control Groups

			Experimental Group		Control group	
Performances	**Grades**	**Score (100)**	**No. of learners**	**Percentage**	**No. of learners**	**Percentage**
Highest	1	90-100	3	7.5	0	0
Higher	2	80-89	15	37.5	5	12.2
High	3	70-79	10	25	3	7.3
High Average	4	60-69	7	17.5	4	9.8
Average	5	55-60	3	7.5	12	29.3
Low average	6	50-54	1	2.5	5	12.2
Low	7	40-49	1	2.5	3	7.3
Lower	8	35-39	0	0	2	4.9
Lowest	9	0-34	0	0	5	12.2
		Total	42	100	41	100

Source: Scores of learners (2023).

From Table 2, the post-test score indicated that the score (90-100) highest score saw 3 (7.5%) of the experimental group and 0 (0%) of the control group obtaining that. Also, many 15 (37.5%) of the experimental group and only 5 (12.2%) of the control group scored (80-89) higher in the post-test. Again, more than 10 (25%) of the experimental group and only 3 (7.3%) of the control group scored (70-79) high in the post-test results. Again, 7 (17.5%) of the experimental group and 4 (9.8%) of the control group scored (60-69) high average of the post-test results. Also, the score (55-60) average saw only 1 (2.5%) of the experimental group and 12 (29.3%) of the control group, while 2 (5%) of the experimental group and 5 (12.2%) of the control group scored (50-54) low average in the test. Again, only 1 (2.5%) of the experimental group and 3 (7.3%) of the control group scored (40-49) low on the test. Also, only 1 (2.5%) of the experimental group and 2 (4.9%) of the control group scored (35-39) lower on the test and no 0 (0%) learners of the experimental group and few 5 (12.2%) of the learners in the control group scored (0-34) lowest in the post-test.

4. Discussion of Results

From the post-test results, both groups showed an increase in their academic performance. However, the experimental group had greater improvement than the control group comparing the post-test scores of the two groups. Based on the performance level, the experimental group had a much improvement than the control group.

From the post-test results, there were learners in the experimental group who reached the highest score level while no learner in the control group reached that level. On average, more learners perform outstandingly in the experiment group than in the control group. The results confirmed that the use of differentiated instruction had increased learners' performance significantly higher than the conventional method of facilitating.

This finding confirms the study by Aranda and Zamora (2016) and Konstantinou-Katzi et al. (2013) that differentiated instruction had much improvements and positive impact on the academic performance of learners and Muthomi and Mbugua (2014) who investigated the effects of differentiated Instruction on learners' achievement in mathematics in secondary schools in Meru County in Kenya wherein a significant increase in the learner's achievement was noted. Likewise, the research of Tambaoan and Gaylo (2019) on Differentiating Instruction in a Mathematics Classroom: Its Effects on Senior High School Learners' Academic Performance and Engagement in Basic Calculus showed that learners performed better when differentiated instruction was used in the instructional process in the classroom.

In the course of the intervention, it was realized that learners in the experimental group were very active, attentive in class, and participated fully. Every learner there was seen doing something in the course of facilitating in the experimental class while the control group was not active, Learners were seen only observing the Facilitators facilitating and the class was not active and learners were not given the chance to express themselves this made the control class very bore leading to poor performance.

The class engagement was very good and all these gave learners a lot of opportunities to ask questions. From the results, it was viewed that most learners do not like mathematics because of the mode of facilitating the mathematics curriculum.

4.1 Conclusion

Using differentiation in the mathematics classroom in facilitating common fractions at the basic 7 levels significantly increased the academic performance and participation of learners. It supported the improvement of the academic performance of learners and increased their participation. From the pre-test learners' performance was very bad and their understanding of the topic was low. However, after the intervention using differentiated instruction in the classroom, most learners performed better in the experiment group than the conventional group in the post-test, meaning the use of differentiated instruction will help in solving the poor performance in the subject area because this method will give opportunities to all learners to participate in the classroom when facilitators incorporated it into their lessons.

4.2 Recommendations

Since the use of differentiated instruction in mathematics classrooms aids in the general good performance of learners, supervisors like mathematics coordinators, CISOs, heads, and facilitators, must ensure that facilitators use differentiated instruction in their classrooms. Also, mathematics facilitators must use differentiated instruction in the facilitating and learning process in the classroom to help enhance learners' full participation and help improve their academic performance.

Again, the Ministry of Education, Ghana Education Service, and other organizations in education and child development must periodically organise workshops in-service training, and Seminars in differentiated instruction to boost and equip facilitators with knowledge and skills as to the use of differentiated instruction in their lessons. Mathematics facilitators must also research the area of differentiated instruction to gain knowledge and skills in the use of differentiated instruction.

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