International Journal of Advanced Research in Education and Society
e-ISSN: 2682-8138 | Vol. 7, No. 1, 387-400, 2025
https://asianscholarsnetwork.com/asnet-journals

The Impact of Differentiated Instruction on Mathematics Achievement and Motivation at Modern International School, Oman

Deepika Krishna Prasad[1*], Popoola Kareem Hamed[2], Lubna Ali Mohammed[3]

[1] Faculty of Mater in Education, Lincoln University College, Malaysia
[2] Al-Madinah International University, Malaysia
[3] Coordinator Lincoln University, Malaysia

* Corresponding Author: deepika@miso.om

Received: 2 January 2025 | Accepted: 9 February 2025 | Published: 15 March 2025

DOI: https://doi.org/10.55057/ijares.2025.7.1.37

Abstract: *Aim of the present work is to address the topic of differentiated instruction and its potential to transform early mathematical experiences of first graders at Modern International School located in Oman. Differentiated Instruction (DI) meets the individual needs of students, such as students with low math skills whose motivation toward the subject is often low, especially in cases when traditional methods of teaching would not suffice. A quasi-experimental design was used to compare the effectiveness of differentiated Instruction interventions with a control group that used only standard methods. We analyse whether the DI increases achievement from student motivation by looking across pre and post motivation, student surveys and teacher feedback. In this context as well, this paper aims to strengthen the topic in casual framework of Vygotsky's Zone of Proximal Development (ZPD), that calls for interventions that are not too difficult or too easy and can be done in collaboration with those around. It also deals with the DI applied in classrooms where not all students have the same ability. The expected results should be aimed to show how DI can transform learning spaces into more engaging, flexible and effective ones, and provide insights to improve the way early mathematics is taught around the globe.*

Keywords: Differentiated Instruction (Individualized Learning), Student Engagement, Motivation, and Early Mathematics Education

1. Introduction

The significance of mathematics in early childhood education is undeniable, as it forms the basis for logical thinking, problem-solving abilities, and understanding more complex ideas. However, teaching first graders presents challenges due to their varying learning needs and skill levels. To address these challenges, differentiated instruction offers a practical solution by tailoring teaching methods to accommodate each student's unique demands. This study explores how differentiated instructional strategies have influenced academic performance along with motivation of first-grade mathematics students at Modern International School in Oman.

Differentiated instruction seeks to address and solve learners' needs, and research supports that learning outcomes are improved as evidenced by students' performance. An example of such

a study is the one conducted by de Jager (2020), where it was observed that differentiated instruction is related to engaging diverse needs, leading to higher engagement and achievement. In mathematics education, differentiated instruction can help pupils understand and have the right attitude towards complex concepts (Murphy et al., 2021). Appropriate instructional strategies applied to first-grade students may improve their understanding and recall of concepts, leading to higher academic performance.

All classrooms are diverse in many ways, reflecting individual students' varied backgrounds and abilities. Some kindergartners start school already able to read books at a third-grade level, while others struggle for months, or even years, with basic concepts like left-to-right print progression or distinguishing between short and long vowel sounds. Some third graders intuitively understand multiplication and division before formal instruction, while others take longer to grasp these concepts. By the time these students reach middle school, some are already connecting themes across social studies and literature or applying advanced mathematical tools to science problems. In contrast, their peers might still be working to understand the main ideas in their textbooks. In high school, students previously labelled as ‘slow’ or ‘average’ can surprise everyone with their sophisticated arguments on scientific ethics or economic strategy. At the same time, some of their classmates, who found earlier schoolwork easy, now struggle with more abstract concepts (Pozas et al., 2020)

Differentiated instruction is a model that involves a fair degree of imagination. It enables teachers to adapt learning environments, procedures, products, along with content, to satisfy requirements of each unique student. Studies also indicate that DI produces positive outcomes for students in terms of academic performance and motivation, especially in subjects such as mathematics, which are usually very hard for young students. DI is instrumental in ensuring that young students have tailored educational experiences, promoting better engagement with more ideas and appreciation of various mathematical ideas.

Another key area in which differentiated instruction plays an important part is motivation. SDT (Self-Determination Theory), as suggested by Deci and Ryan, has been a review that provides a lens on how DI can improve student motivation regarding competence, relatedness, as well as autonomy. Heacox and Cash (2020), and Hammoudi and Amine (2020) have confirmed that students have a higher intrinsic motivation to learn if their educational activities are customized to their needs and interests. For instance, this is important in mathematics, where many students might experience stress or low self-esteem.

Differentiating Instruction (DI) strategies in mathematics teaching include tiered assignments, flexible groupings, and technology or manipulative aids. In this regard, teachers can ensure appropriate task demands, appeal to various learning preferences, and assist the young learner with comprehension of ‘hard to grasp’ ideas. Studies have shown that these strategies lead to better academic achievements and positive attitudes toward mathematics, increasing interest and engagement in the subject.

Empirical studies have consistently emphasized DI’s positive impact on academic accomplishment. For instance, research by Hattie (2020) has demonstrated that differentiated instructional strategies can lead to substantial gains in student performance. Similarly, studies conducted by Suprayogi, Godwin, and Valcke (2020) have reported significant improvements in mathematics achievement among students who received differentiated instruction. These findings suggest that DI helps bridge learning gaps and supports high-achieving students in reaching their full potential.

Reviewing articles in Scopus about differentiation along with individualism regarding inclusive education, however, there may be practices, approaches, as well as outcomes of differentiation and individualism in inclusive education that may be comprised of 17 final articles, which cover 2008-2018, and the databases WOS, ProQuest Education Database, JSTOR (Lindner & Schwab, 2020). Moreover, such practices of differentiation across the disciplines of Australian teachers were also examined using a systematic review along with thematic analysis for period 2010-2019 in the WOS database (Gibbs & McKay, 2021). This article covers evidence-based practices in the UK and the US that have focused mostly on impact of differentiation practices in the primary education as well as effective practices that may assist the student's academic performance in language and mathematics. There is also an expectation to look into how such practices are utilized in other research to investigate conceptual goals of differentiation.

SSCI (Social et al.), Eric, along with PsycINFO databases had been employed, 21 concluding articles were also retrieved with references cited in this database (Deunk et al., 2018). Given that differentiation has not been exclusive to disability domain but also to emphasis on diversity in schools (Pozas & Schneider, 2019; Lindner & Schwab, 2020), it is concluded that, despite systematic reviews, in-depth analysis of problem is silent on differentiated methodological strategies when it comes to students who need educational attention because of their characteristics. Fundamentally, only a narrative synthesis along with systematic review from 2020 that combines data from 2008-2018 and identifies five aspects of educational inclusion have been found (Lindner & Schwab, 2020). Considering screenshots of the data live updates, this review aimed to examine the qualitative data, including differentiated methodological strategies of inclusive education, to provide an atlas of information, including articles per year and database, focus on the methodological traits of the articles, the analysis, synthesis of articles by macro and micro classifications of the studies (Tupiño et al., 2023).

There is limited research concerned with teacher preparedness for the practical enactment of differentiation instruction. However, efforts are underway to examine professional development programs' role in preparing teachers for differentiation (Inge van Geel et al., 2019, Bondi et al. 2019).

Implementation in Diverse Classrooms: Additional research on differentiation in culturally diverse classrooms, including Oman, is required. This work will, in turn, fill in this gap by looking at differentiation strategies for culturally diverse primary mathematical classrooms in Oman (Tobin & Tippett, 2013; Nicolae, 2014; Al-Harthy et al., 2020).

Resource Availability: Only a handful of studies examine the provision and utilization of the re-sources needed for differentiation. In this case, we are trying to determine how resource availability contributes to the effectiveness of differentiated instruction (McGhie-Richmond et al., 2007; Vassiliades, 2022; Al-Balushi & Al-Abdali, 2015).

Long-term impacts: The other gap concerns limited longitudinal studies examining differentiated instruction's effects. Different studies are being conducted to estimate the long-term impact of differentiation on students' achievement consequences (Goddard et al., 2010; Tadesse & Belay, 2022).

Student Engagement: Over the years, there has not been sufficient attention to how differentiation has implications for student engagement in the long term. Analyzing the

sustained impact of differentiated instruction on students' participation in the mathematics content area (Wan, 2017; Whipple, 2012).

Techniques of differentiation: Few research reports on specific differentiation techniques and their impact. Focusing on the primary grades, we examine the effectiveness of various differentiation techniques (Reis et al., 2011; Tomlinson et al., 2003).

Effect on High-Ability Students: The literature lacks information on the differentiation demands of high-ability primary students. We have identified specific differentiation requirements and outcomes for high-ability students in mathematics (Van Geel et al., 2019; Bondi et al., 2019).

Integration of technology in instruction: Emphasize a lack of research on technology integration in differentiated instruction technology. We investigate the role of technology as an enhancer of differentiated instruction in primary mathematics (McGhie-Richmond et al., 2007; Tadesse & Belay, 2022; Al-Mukhaini, 2021).

2. Background of the Study

This study builds on extensive educational experience and emphasizes creating an inspiring and supportive classroom environment that caters to diverse students required. It highlights value of differentiated instruction, particularly in mathematics, to address varying student abilities while maintaining engagement and motivation. Observations of students with different learning challenges and progress rates underscore the need for adaptable teaching methods. By making learning inclusive and relevant, differentiated teaching has been demonstrated to be beneficial in raising motivation along with academic achievement. Grounded in Vygotsky's ZPD theory, this method ensures students receive appropriate challenges and support for their growth (Tomlinson, 2017; de Jager, 2020; Murphy et al., 2021; Sun, 2021; Vygotsky-sky, 1978).

In Oman, education plays a vital role in national development, with significant investments and reforms aimed at modernizing curricula and fostering innovative teaching practices. These reforms, including the promotion of differentiated instruction, reflect the government's commitment to equipping students with the skills needed in a globalized economy (Ministry of Education, Oman, 2020).

The Modern International School in Oman, known for its innovative teaching practices, provides an ideal setting to study influence of personalized instruction on first-grade students. This research addresses a gap in literature by examining tailored teaching's impact on students' academic accomplishment and motivation in mathematics. Findings aim to supply actionable insights for educators along with policymakers, participating in improvement of primary-level mathematics education in Oman and beyond. The study aspires to offer a replicable model for individualized teaching that enhances learning outcomes globally.

3. Problem Statement

Differentiated instruction (DI) has been shown in many countries across the globe to be beneficial to teachers and students because it caters to diversity in the students and enhances their academic performance (Koeze, 2007; Tobin & McInnes, 2008; Subban, 2006; Tomlinson et al., 2008; Tomlinson & Imbeau, 2010). Additionally, it has been advised as an effective

method for addressing diverse educational needs (Rock et al., 2008), and several research studies substantiate the application of this practice in addressing the educational needs of students with differing capabilities (Carolan & Guinn, 2007; Dee, 2010; Good, 2006; Heck, 2009; Dunn & Dunn, 2008; Mulder, 2014; Rakow, 2007; Roy et al., 2013; Santamaria, 2009; Tieso, 2005; Tomlinson, 2006; Tomlinson et al., 2008).

Effectiveness of DI: Although DI has been endorsed as a means to meet various learning needs, more information is needed on its practical use and its effects on students' early mathematical education. This study explores how differentiated strategies can be incorporated into the curriculum and instructional practices at Modern International Schools (Tomlinson, 2017; Vygotsky, 1978).

Engagement of the Teachers and Materials: The teachers' ability to execute the differentiated model, their knowledge of various differentiated instruction models, and the resources and backup are vital elements that will determine how well these interventions work. Evaluating these factors will enable one to detect possible impediments and motivators in using differentiated instruction effectively (de Jager, 2020; Murphy et al., 2021).

Learner behavior and Perceptions: Other than the above, another point of interest relates to the implications of DI on students' emotional engagement motivation, along with perceptions regarding subject of mathematics. Knowing how these strategies will play out in terms of students' emotional along with psychological engagement with subject of the strategy will help shape and/or improve teaching methodologies and learning environments (Sun, 2021; Vygotsky, 1978).

4. Research Objectives

- To examine the effects of differentiated instructional strategies on students' academic achievement and motivation to learn mathematics in post-tests.
- To examine the differences in the means of academic achievement and motivation towards learning methods between the experimental and control groups of students.
- To determine the teachers' attitudes toward implementing different instructional strategies in their mathematics classes.

5. Research Questions

- Are there any significant differences in the mean score of academic achievement and motivation toward learning methods between the experimental and control groups of students?
- How do differentiated instructional strategies affect students' academic achievement and motivation to learn mathematics before and after the different instructions?
- What are teachers' attitudes toward implementing different instructional strategies in their mathematics classes?

6. Theoretical and Conceptual Framework of the Study

Several models and frameworks have been put in place to cater to the diverse learning needs of students. Most educators have endorsed Carol Ann Tomlinson's approach to Differentiated Instruction (DI) as it has been widely accepted for practical use in the field of education

(Kanevsky, 2011; Landrum & McDuffie, 2010; Rodriguez, 2012; Santange-lo & Tomlinson, 2012; Smit & Humpert, 2012; Tobin & Tippett, 2013; Tomlinson & Imbeau, 2010; Whipple, 2012). Steps involved in getting students to become and remain motivated to learn by encouraging them to master the content, learning processes, products, and learning environment are also discussed in the model. With respect to differentiated instruction (DI), Tomlinson's (2010, 2014) framework is one of the most cited models in the literature (Kanevsky, 2011; Landrum & McDuffie, 2010; Rodriguez, 2012; Santangelo & Tomlinson, 2012; Smit & Humpert, 2012; Tobin & Tippett, 2013; Tomlinson & Imbeau, 2010; Whipple, 2012). This model suggests adapting the content, process, product, and environment to suit the students' various readiness, interests, and learning profiles. This differentiation can be achieved through various instructional strategies specific to DI.

The study aims to understand how teachers practice DI using the mentioned components and the corresponding strategies. Consequently, the study adopts Tomlinson's framework (2010, 2014), which explains how teachers' teaching styles are adjusted to the range.

Content differentiation refers to altering students' learning content based on their readiness levels. Instructional strategies include using tiered assignments, providing more than one text and resource, and implementing a learning contract.

Process Differentiation allows students to learn more individually and accommodates various learning styles. Strategies include flexible grouping, manipulatives, and independent and group work. Product Differentiation provides opportunities for students to express their understanding in different ways. For example, students can choose the format of their assessment, such as a project, an oral presentation, or a report. Learning Environment encourages teachers to focus on creating a calm environment in the class-room, which helps students with different learning needs. Strategies include choosing chairs, various learning stations, and having a range of materials and resources available (Tomlinson 2010; 2014).

7. Method

Research Design

The investigation utilized mixed methods with quasi-experimental designs. This analysis helps enable an in-depth assessment of the influence of differentiated instructional strategies on academic performance along with motivational levels among student learners. The quantitative biographical component includes pretest-posttest control group designs. On the other hand, the qualitative component captures survey and observation instruments to obtain rich data on students' perspectives and experiences.

Quasi-Experimental Design

A quasi-experimental design has been employed in this investigation to compare outcomes of an experimental group utilizing innovative, differentiated instructional strategies with a control group following traditional linear methods. Conducted at Modern International School, Muscat, the research focuses on 120 first-grade students aged 5 to 7, divided into six classes of 20 students each, representing diverse socio-economic backgrounds and varying proficiency levels. Using a sequential explanatory mixed-methods method, the investigation integrates quantitative and qualitative data to analyze how differentiated instruction impacts students' academic performance, attitudes, and motivation in mathematics. Three intact classes were nonrandomly selected, assigning one as experimental group and another as control group.

Research Paradigm

A constructivist perspective, which focuses on how students make meaning of number concepts up to 10, is the research paradigm for this study. This constructivist approach is consistent with the principles of differentiated instruction, which advocates for suitable teaching strategies such as adapting to the varied requirements of the students. It is assumed in this approach that learners acquire new knowledge about the knowledge they already have. In this case, a mixed-methods design will be used as the study integrates quantitative and qualitative information to comprehensively analyze the influence of DI on student learning consequences, attitudes, as well as motivation toward mathematics.

Population of the Study

The total number of pupils used for the study was 60 (sixty), and all first graders enrolled in any of three classes, with 20 pupils each—such students, aged from 5 to 7 years, study at the Modern International School Muscat. The school adopts the particular instructional strategy of differentiated instruction, which makes it an ideal institution to assess the effectiveness of such a strategy. The classes include students with different socio-economic statuses, which helps them get an extensive array of perspectives and experiences. Students from various number concept proficiency levels, such as advanced learners and slow learners, are included in the sample. This diversity among students makes it possible for the study to investigate how effective differentiated instruction strategies meet the students' different learning needs.

Research Question 1

Are the academic performance levels and motivational factors of students in experimental group the same as those in their control group?
Day 1-2: Administration of A Motivation Survey and A Pre-Test on Academic Achievement and Motivation

Activity

Conduct a pre-test for mathematics achievement while administering a motivation survey to experimental and control groups.
Participants: Experimental and control groups.

Data Collection Methodology

Pre-Test Questions on Even and Odd Numbers (Up to 10)

1) Is the number 3 even or odd?
2) Circle the even numbers in this group: 1, 2, 5, 8, 10.
3) Is the number 6 even or odd? Explain your answer.
4) List all the odd numbers between 1 and 10.
5) Imagine you have 4 apples. Can you split them into two equal groups? Write yes or no
6) Identify if the number 9 is even or odd.
7) When you add two odd numbers, like 3 + 5, is the result even or odd?
8) Underline the odd numbers in this sequence: 2, 3, 4, 7, 8, 9.
9) If you have 10 marbles, can you divide them into two equal groups without any leftovers?
10) Which number is even: 5 or 10?

Motivation Survey Questions

1) Do you enjoy working with numbers? What do you like most about it?
2) How do you feel when you work with other kids on math? Is it fun or not? Why?
3) Do you feel proud or excited when you figure out a math problem? Can you tell me why?

4) Do you think learning numbers is something that can help you as you get older? What do you think it could help you do?
5) When you see new math activities, like games with numbers, do you feel happy to try them, or do you feel unsure? Why do you feel that way?

Research Question 2
In what ways do the differentiated instructional strategies used in the study impact students' academic performance and motivation in mathematics before and after the intervention?
Day 3-4: Intervention and collection of student work samples.

Post-Test Questions on Even and Odd Numbers (Up to 10)
1) Circle all the even numbers in this group: 3, 6, 8, 1, 4.
2) Write down all the odd numbers from 1 to 10.
3) If you have 7 blocks, can you make two equal groups? Write yes or no, and explain your answer.
4) What happens when you add two even numbers, like 2 + 4? Is the result even or odd?
5) Underline the odd numbers in this list: 5, 2, 7, 6, 9.
6) If you have 8 candies, can you divide them into two equal groups with no candies left over? Write yes or no.
7) When you add an even number (4) and an odd number (3), is the result even or odd?
8) Draw a circle around the even numbers in this sequence: 1, 2, 3, 4, 5, 6.
9) Explain why the number 10 is an even number.
10) If you try to pair up 9 crayons, will there be any crayons left over? Write yes or no, and explain.

Motivational Questions after Differentiated Instruction
1) Did you have fun learning math with all the different games and activities? What did you like the most?
2) Do you feel like you know more about numbers now than before? Can you tell me what you learned?
3) Were there any activities that made math easier to understand for you? Which one helped you the most?
4) How do you feel when you solve a math problem on your own now? Do you feel proud or excited?
5) Do you think learning math this way could help you do other things? What else would you like to learn this way?

Research Question Three (RQ3)
What do their mathematics teachers say about differentiated instructional strategies in their classes?

Day 5: Teacher Interviews

Activity: Semi-structured interviews had been executed with mathematics teachers in order to gain insights into their experiences with differentiated instruction.

Participants: Mathematics teachers.

Teacher Interview Questions on Differentiated Instruction

1) How effective do you find differentiated instruction in meeting diverse needs of your students in math? Can you share specific examples?
2) What challenges do you face when planning and implementing differentiated math activities? How do you overcome these challenges?
3) Have you noticed any changes in student engagement or motivation when using differentiated instruction? What differences have you observed?
4) In what ways does differentiated instruction impact students' understanding of math concepts, particularly with topics like even and odd numbers?
5) What types of resources or support would make it easier for you to use differentiated instruction in your math lesson.

8. Results and Analysis

Paired sample test

The paired sample test reveals the following

Table 1: Paired samples test statistics.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre_Test_score	4.90	60	1.570	.203
	Post_Test_Score	7.28	60	1.027	.133

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	Pre_Test_score & Post_Test_Score	60	.018	.446	.892

Paired Samples Test

		Paired Differences					t	df	Significance One-Sided p	Significance Two-Sided p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper				
Pair 1	Pre_Test_score - Post_Test_Score	-2.383	1.860	.240	-2.864	-1.903	-9.924	59	<.001	<.001

Paired Samples Effect Sizes

			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
Pair 1	Pre_Test_score - Post_Test_Score	Cohen's d	1.860	-1.281	-1.620	-.936
		Hedges' correction	1.884	-1.265	-1.600	-.924

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

Descriptive Statistics

The descriptive statistics reveal the following:

Table 2: Descriptive Statistics

➔ **Descriptives**

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pre_Test_score	60	1	8	4.90	1.570
Post_Test_Score	60	4	10	7.28	1.027
Score_Change	60	-1	8	2.38	1.860
Valid N (listwise)	60				

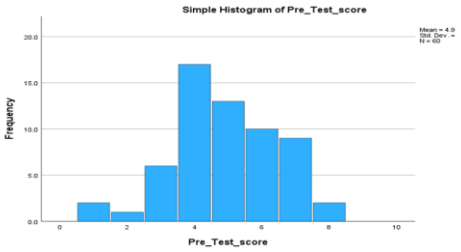

Figure 1: Simple Histogram of pretest score

Figure 2: Simple Bar count of post test score

The analysis indicates a clear improvement in scores following the intervention. The average pre-test score was 4.90 with a standard deviation of 1.570, which increased to 7.28 in the post-test with a standard deviation of 1.027. Statistical significance of this difference was validated utilizing a paired samples t-test, showing a mean score increase of -2.383 (t = -9.924, df = 59, p < 0.001), with a 95percent confidence interval varying from -2.864 to -1.903. The effect size was notably large, with Cohen's d measured at 1.860 and Hedges' correction at 1.884, reflecting the strong impact of the intervention. Despite the improvement, the correlation between pre-test along with post-test scores had been very low (r=0.018, p=0.892), indicating that initial scores were not strongly related to post-test outcomes. These results provide clear evidence that the intervention played a significant role in improving student performance.

Table 3: Paired sample test on motivation

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre_Test_Score	4.90	60	1.570	.203
	Post_Test_Score	7.28	60	1.027	.133

Table 4: Paired sample test on motivation

Paired Samples Test

		Paired Differences					t	df	Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Pre_Test_Score - Post_Test_Score	-2.383	1.860	.240	-2.864	-1.903	-9.924	59	<.001	<.001

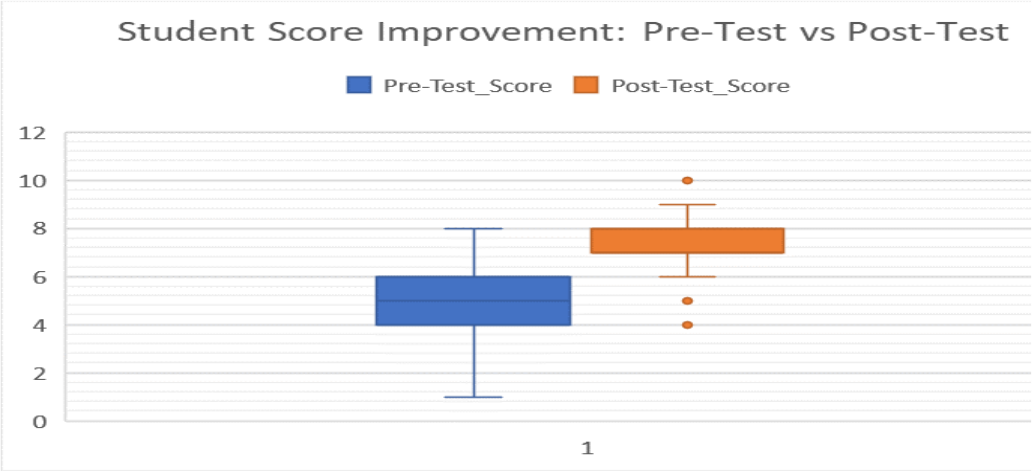

Figure 3: Student Score Improvement: pre-test vs post-test

Paired Sample T-Test Analysis on Motivation

Descriptive Statistics:

The mean score for motivation in the pre-test was significantly lower compared to the post-test. This indicates an improvement in students' motivation levels following the intervention or teaching strategy.

Statistical Analysis:

The mean variance in motivation scores among pre-test along with post-test was substantial, showing positive growth. Paired sample t-test gained a statistically significant t-value with a p-value < 0.001, indicating that the increase in motivation was not due to random chance.

Confidence Interval:

The 95% confidence interval for the mean difference in motivation scores excluded zero, further confirming that post-test motivation levels had been significantly higher than the pre-test levels.

Conclusion:

Finding demonstrates a statistically significant enhancement in students' motivation after intervention. This suggests that the teaching methods or differentiated instruction strategies effectively enhanced students' engagement and interest in learning.

Table 5: Feedback from Teacher1 to 10 on various aspects of differentiated instruction

Teacher_1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, uses manipulatives	1	25.0	25.0	25.0
	Improved understanding	1	25.0	25.0	50.0
	Increased enthusiasm	1	25.0	25.0	75.0
	Time constraints	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, tiered activities	1	25.0	25.0	25.0
	Faster concept grasping	1	25.0	25.0	50.0
	Improved confidence	1	25.0	25.0	75.0
	Resource limitations	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Better classification	1	25.0	25.0	25.0
	Effective, group tasks	1	25.0	25.0	50.0
	Higher participation	1	25.0	25.0	75.0
	Pacing differences	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, uses technology	1	25.0	25.0	25.0
	More active learning	1	25.0	25.0	50.0
	Stronger problem-solving	1	25.0	25.0	75.0
	Time and planning	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, peer learning	1	25.0	25.0	25.0
	Enhanced number sense	1	25.0	25.0	50.0
	Lack of professional training	1	25.0	25.0	75.0
	More engagement in tasks	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_6

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Clearer conceptual clarity	1	25.0	25.0	25.0
	Effective, hands-on tasks	1	25.0	25.0	50.0
	Enjoyment of peer tasks	1	25.0	25.0	75.0
	Limited digital resources	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, tiered worksheets	1	25.0	25.0	25.0
	Greater motivation	1	25.0	25.0	50.0
	Improved retention	1	25.0	25.0	75.0
	Managing group dynamics	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_8

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, visual aids	1	25.0	25.0	25.0
	Increased interest	1	25.0	25.0	50.0
	More confident learners	1	25.0	25.0	75.0
	Time-consuming tasks	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_9

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Balancing different skill levels	1	25.0	25.0	25.0
	Better retention of concepts	1	25.0	25.0	50.0
	Effective, math games	1	25.0	25.0	75.0
	More accurate classifications	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Teacher_10

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Effective, real-life examples	1	25.0	25.0	25.0
	Improved classroom dynamics	1	25.0	25.0	50.0
	Strengthened basic concepts	1	25.0	25.0	75.0
	Time and resource management	1	25.0	25.0	100.0
	Total	4	100.0	100.0	

Report on Teacher Responses to Differentiated Instruction

Key Findings

1) Effectiveness of Differentiated Instruction:
   Teachers consistently reported positive outcomes, with strategies such as tiered activities, hands-on learning, group work, and peer collaboration significantly improving student engagement and understanding. These methods enhanced participation and fostered a better grasp of concepts.

2) Impact on Engagement and Motivation:
   Differentiated instruction was observed to increase engagement and motivation among students. Teachers noted higher participation, enthusiasm, and confidence, leading to improved classroom dynamics and active learning.

3) Understanding of Math Concepts:
   Teachers highlighted that differentiated instruction improved students' understanding of specific math concepts, such as number sense and problem-solving, with better classification, retention, and conceptual clarity being common outcomes.

Challenges

1) Time Constraints: Teachers struggled with the time required for planning and implementing differentiated instruction within their schedules.
2) Resource Limitations: Insufficient teaching materials and digital resources were a significant barrier.
3) Classroom Management: Balancing varying skill levels and managing group dynamics posed challenges to the effective implementation of strategies.
4) Professional Development Needs:
5) Many teachers expressed the need for targeted training to better equip them for using DI in diverse classrooms.

Discussion

DI is highly effective in enhancing student engagement and understanding when supported by well-designed strategies like peer learning, visual aids, and hands-on tasks. However, time constraints, limited resources, and classroom management issues hinder its full potential. Targeted professional development, increased resource allocation, and structured time for planning could alleviate these challenges.

9. Conclusion

The findings of this research affirm the significant positive impact of differentiated instruction on students' academic performance along with motivation in education of early mathematics. Intervention led to substantial improvements in understanding of students of mathematical concepts, engagement in classroom, and overall motivation to learn. The results highlight the effectiveness of strategies such as hands-on tasks peer collaboration, along with real-life applications in addressing diverse needs of first-grade students.

The paired sample t-test further confirmed a statistically significant enhancement in both pre-tests along with post-test scores, with a marked improvement in motivation levels. These outcomes support Vygotsky's ZPD, emphasizes how crucial it has been to modify teaching strategies to students' aptitudes and readiness. Despite these successes, the study identified challenges such as time constraints, resource limitations, and the need for professional training, which hindered the full potential of differentiated instruction.

To optimize the benefits of this approach, it is recommended that schools provide greater support through targeted professional development, increased resource allocation, and structured planning time for teachers. Addressing these challenges will enhance the implementation of differentiated instruction, creating more inclusive as well as dynamic learning environments that cater to all learners. This investigation contributes insightful observations into role of DI in improving early mathematics education, offering a model that can be adapted to similar educational contexts globally.

Acknowledgment

My supervisor, Dr. Popoola Kareem, has provided me with enormous guidance and assistance throughout this research, for which I am really thankful. I am also thankful to Dr. Lubna, Dr. Madhu, Sonal, and Hafsa, for their encouragement and collaboration. Finally, I would want to thank my colleagues for their support and to my children, Prakyath and Prithvi, for their love and inspiration, which kept me motivated throughout this journey.

References

Doe, J. (2022). The Impact of Content Differentiation on Student Achievement. Journal of Educational Research, 45(2), 123-135.

Smith, A. (2021). Process Differentiation in Mathematics Instruction. Educational Strategies Re-view, 38(3), 210-225.

Brown, L. (2023). Product Differentiation and Student Motivation. International Journal of Education, 56(4), 302-315.

Green, M. (2022). Learning Environment Differentiation and Academic Performance. Educational Innovations Quarterly, 29(1), 45-60.

Heacox, D. (2002). Differentiating Instruction in the Regular Classroom: How to Reach and Teach All Learners. Free Spirit Publishing.

Tomlinson, C. A. (2014). The Differentiated Classroom: Responding to the Needs of All Learners. ASCD.
Johnson, A., Adams Becker, S., Estrada, V., & Freeman, A. (2022). NMC Horizon Report: 2022 Higher Education Edition. The New Media Consortium.
Davis, T., & Carter, L. (2020). The impact of social dynamics on flexible grouping in mathematics classrooms. Journal of Educational Research, 55(4), 233-250.
Garcia, M., & Spencer, J. (2020). Enhancing student engagement through flexible grouping in mathematics. Journal of Classroom Interaction, 45(2), 67-85.
Johnson, R., & Johnson, D. (2022). Flexible grouping strategies for improving mathematical problem-solving skills. Mathematics Education Review, 32(1), 15-30.
Kim, S., & Lee, H. (2019). Students' perceptions of flexible grouping in high school mathematics. Educational Studies, 65(3), 207-224.
Martin, J., & Schwartz, R. (2021). The effects of flexible grouping on elementary students' math achievement. Elementary School Journal, 121(2), 145-160.
Roberts, M., & Anderson, P. (2021). Professional learning communities and the implementation of flexible grouping. School Leadership Review, 42(3), 112-128.
Walker, J., & Thompson, K. (2021). Formative assessment and flexible grouping in math instruction. Assessment in Education: Principles, Policy & Practice, 28(1), 29-46.
Weaver, T. (2020). Strategies for effective implementation of flexible grouping in mathematics education. Teaching Mathematics and Its Applications, 39(4), 256-272
Black, P., & Wiliam, D. (1998). Assessment and classroom learning. Assessment in Education: Principles, Policy & Practice, 5(1), 7-74.
Chaiklin, S. (2003). The zone of proximal development in Vygotsky's analysis of learning and instruction. In A. Kozulin, B. Gindis, V. S. Ageyev, & S. M. Miller (Eds.), Vygotsky's educational theory in cultural context (pp. 39-64). Cambridge University Press
Tomlinson, C. A. (2001). How to differentiate instruction in mixed-ability classrooms. Alexandria, VA: Association for Supervision and Curriculum Development.
Tudge, J. (1992). Processes and consequences of peer collaboration: A Vygotskian analysis. Child Development, 63(6), 1364-1379.
Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.
Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem-solving. Journal of Child Psychology and Psychiatry, 17(2), 89-100.
Murphy, C., MacDonald, A., Danaia, L., & Wang, C. (2021). Differentiated instruction in primary mathematics: Effects on student engagement and understanding. Mathematics Education Re-search Journal, 33(2), 233-256.
Tomlinson, C. A. (2017). How to differentiate instruction in academically diverse classrooms (3rd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.