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Long Paper

Differentiated Instruction in Mathematics Classes: Increasing Student's Mathematics Performance and Engagement in Statistics and Probability

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Abstract

To provide high-quality basic education, the mathematics teacher must handle many difficulties, including student diversity. Lack of student engagement and poor mathematics achievement will occur unless student diversity is addressed. This study used differentiated instruction to increase the Grade 11 students' mathematics performance and mathematical engagement in Statistics and Probability. The study used a Plan-Do-Study-Act-inspired practical action research design. Specialists in mathematics education verified the data collection tools, including the survey questionnaire, test materials, and interview guide, and pilot-tested them with non-participants. The results showed that differentiated instruction boosted the students' mathematical engagement in terms of cognitive, behavioral, emotional, and social aspects. Additionally, students performed better mathematically on the test. Students gained confidence and increased interest in studying because their preferred learning styles and interests were considered while creating the lessons.

Keywords – differentiated instruction, mathematics performance, secondary student, student engagement, student diversity

INTRODUCTION

Secondary students practice various types of mathematics learning activities. Therefore, teachers must adapt their teaching strategies and activities to accommodate student diversity. In light of this, differentiated instruction is necessary due to each secondary student's characteristics. Differentiated instruction (DI) holds that students are unique and learn differently (Fogarty & Pete, 2017). Based on the assessed students' characteristics, such as interest, readiness, and learning profile, DI alters the learning material, process, product, and environment (Roy et al., 2013; Tomlinson, 2014). According to Özer and Yilmaz (2018) and Say and Emir (2017), a distinctive aspect of DI is lesson planning based on student interest, readiness, and learning profile to fulfill each student's specific needs. As a result, it allows teachers to use various learning resources, activities, content, and assessment techniques to fit each student's unique learning needs. It suggests that the teacher must present each student with various learning opportunities so they can choose what interests them most when it comes to learning.

Understanding student diversity helps teachers differentiate instruction based on learner preferences, offering influential teaching. Aligning the teacher's paradigm is crucial, as strategies corresponding to the student's learning style engage interest and enthusiasm and increase attention span and motivation. Generally speaking, the National Council of Teachers of Mathematics (NCTM) encourages the implementation of DI in the classroom by prioritizing the accommodation of individual differences among students, taking into account their readiness levels, interest levels, or confidence levels to ensure the complete understanding of mathematics concepts (Smith et al., 2018).

Every school must acknowledge student diversity, which calls for various instructional approaches. One of the elements that the teacher must take into account while planning instruction is student diversity. In the Philippine context, the Department of Education (DepEd) Order No. 035, s. 2016 stated that teachers must address student diversity by providing learning opportunities that meet the requirements of various students. Since every student is different, it is crucial to improve the teachers' knowledge and comprehension of how to take student diversity into account in the classroom. Additionally, to foster class unity and address individual differences, teachers who desire to promote student diversity must differentiate their lessons (DepEd Order No. 035, s. 2016). Moreover, Republic Act No. 10533 (Enhanced Basic Education Act of 2013) sets forth the K–12 curriculum pedagogical approaches in the Philippines, which are collaborative, constructivist, differentiated, integrative, inquiry-based, and reflective. Differentiated instruction is required as a pedagogical strategy in the curriculum.

Due to student diversity, teachers must adapt their teaching methods to consider their students' needs. As a result, teachers must adapt their lessons to students' differing levels of cognitive abilities and learning preferences (DepEd Order No. 021, s. 2019). Therefore, the DepEd requires teachers to use differentiated instruction to accommodate student diversity. To address student diversity and improve learning, the DepEd recommends adopting DI in lesson planning (Luistro, 2016). Tuazon and Torres (2022) asserted that many students put in less effort when learning and are bored with learning new things since they lack motivation and detest mathematics. Moreover, not considering student diversity in lesson planning contributes more to student disconnection of mathematic lessons to real-life applications. So, mathematics teachers must differentiate the teaching-learning activities.

In the local context, San Pedro Relocation Center National High School-Main is a public school in Laguna, Philippines, offering a senior high school program. Humanities and Social Sciences (HUMSS) is one of the academic strands available. The HUMSS students nevertheless require assistance in mathematics classes and increased mathematical engagement. The first grading periodical test results showed that HUMSS students fell short of the 75% mean percentage cut-off, which attracted the mathematics teacher's interest. Low mathematics performance requires immediate action and investigation to increase mathematics competency (Naungayan, 2021; Oribhabor, 2020). This is due to varied learning styles and personal traits that need to be addressed. So, using DI strategies, the math teachers undertake a study. By solving this issue, DI improves students' mathematics performance and engagement more directly.

LITERATURE REVIEW

Differentiated Instruction for Improving Student Mathematical Engagement

Active engagement helps a student succeed academically in mathematics (Wang & Degol, 2014). The engagement was characterized by Wang et al. (2016) as unobservable and observable student interaction features, along with learning activities. Academic performance and involvement depend on student engagement. Student engagement predicts academic decision-making and performance. Therefore, maintaining student engagement in the classroom is necessary to encourage students to come to class. However, for learners from a family with low socio-economic status their engagement in math is declining in secondary school (Martin et al., 2015). So, to promote learning engagement in mathematics, the teacher is required to quantify it and offer intervention (Wang et al., 2016). Furthermore, student engagement increases if teachers give consistent support (Alrajeh & Shindel, 2020).

Student engagement is a multi-dimensional concept (Fredricks & McColskey, 2012; Reschly & Christenson, 2012; Wang & Degol, 2014) made up of three interrelated components such as cognitive, behavioral, and emotional. However, Wang et al. (2016) included the social dimension of student engagement. It depicts the student's behavior, emotions, thoughts, and classroom interactions with other students. Fredricks and McColskey (2012) defined behavioral engagement as how the student handles class-related activities, good conduct, and behavior, as shown by compliance with school rules, attention, focus, completion of homework, and engagement. On the other hand, learning techniques to comprehend the content, perseverance, and self-regulation are used to quantify cognitive engagement (Greene, 2015). Cognitive engagement uses deep learning, self-regulated learning, and cognitive strategies to deal with challenging ideas (Zimmerman, 1990, as cited in Wang et al., 2016).

On the contrary, emotional engagement is characterized by enjoyment, interest, and value of learning—all indicators of interest in and value of the lesson (Fredricks & McColskey, 2012). However, Ansonga et al. (2017) and Ruzek et al. (2016) discovered that a teacher's substantial emotional support results in higher cognitive, social, and emotional engagement levels. Therefore, it is essential to consider emotional factors when teaching and learning. Meanwhile, social engagement is explained by Wang et al. (2016) as the willingness to uphold positive relationships with people while learning, as well as social contact with classmates and teachers. It is crucial to consider all aspects of student engagement that describe how the student behaves in class.

Furthermore, Wang et al. (2016) concluded that more incredible behavioral and emotional engagement results in improved academic achievement. High academic achievement is also a result of having positive interactions with other students in the classroom (Kiefer & Ryan, 2011; Wang & Eccles, 2013). Behavioral engagement is essential to improving academic results and engaging students. It means that increased student engagement leads to incredible academic results and higher school retention rates, which every teacher must maintain to provide high-quality instruction. Student engagement is a sign of motivation that demonstrates engagement with the context of students. Students engaged in their studies frequently attend class and achieve better grades (Bear et al., 2018).

Sadly, students lose interest in learning if they continually need help understanding the lesson, which results in poor academic performance and a decline in learning motivation (Morgan, 2014). However, DI can squelch disinterest and increase enthusiasm for learning. On the other hand, Pedler et al. (2020) listed the teacher's responsibilities for encouraging student engagement, including creating classroom routines and procedures, preparing for high levels of student participation, putting relevant learning into practice, and listening to the students' perspectives. Additionally, making the class interesting for the student, encouraging student interest, adding activities and real-life scenarios, encouraging collaboration, and adapting instruction based on the student's learning needs are all essential in teaching. Through a carefully thought-out class that incorporates various learning activities that cater to the student diversity and pique their interest, the teacher plays a significant role in improving student learning engagement. Hence, DI successfully increased students' motivation, engagement, and performance (Katzi et al., 2013).

Differentiated Instruction for Improving Mathematics Performance

Numerous studies have proven that DI has a good effect on student's academic performance (Chen & Chen, 2018; Özer & Yilmaz, 2018; Valiandes & Neophytou, 2018), also to their school success as compared to traditional teaching methods (Sapan & Mede, 2022). Additionally, DI improves student interest, engagement, and happiness while maximizing their learning capacity (Wilujeng, 2012), resulting in greater student motivation and enthusiasm. The advantages of the DI are based on the idea that each student must have access to a high-quality education through various learning opportunities offered by the teacher during class interaction. Muthomi and Mbugua (2014) stated that differentiated instruction enhanced the academic achievement of the students. Also, by identifying their strengths and unique learning styles in a diverse classroom setting, DI improves the performance of struggling students. Yavuz (2020) discovered that students see DI as a fun, intriguing, and engaging teaching strategy.

It is necessary to investigate how teachers might differentiate their instruction to address student diversity (Prast et al., 2018; Ritzema et al., 2016). Implementing DI in teaching academic subjects must be the main emphasis of the research study (Prast et al., 2015; Ritzema et al., 2016). Thus, implementing DI in the post-pandemic is necessary to boost student engagement and account for student diversity, resulting in improved learning results. However, due to many teaching loads of teachers and lack of time for DI preparation, Pozas et al. (2020) discovered a reduced application of DI practices among advanced secondary school teachers. Similarly, differentiated activities and material design hinder DI implementation (Chiner & Cardona, 2013). Due to the current circumstances, senior high school teachers must implement DI despite the overwhelming workloads by managing time and initiating strategies to cater the student diversity.

Using a quasi-experimental design with students in Grade 11, Morallos (2018) studied the impact of DI on student mathematical performance and attainment goals. She discovered that implementing DI enables students to do better on assessments that require them to solve open-ended questions. DI turned the uninterested students into mathematics explorers, resulting in a productive learning environment in the classroom. On the other hand, Geel et al. (2022) concluded that differentiated tasks and instructions are the most widely used and effective ways to help students improve their mathematical abilities.

Numerous educational institutions worldwide use DI (Suprayogi & Valcke, 2016). Nevertheless, much empirical research has yet to examine how teachers use DI strategies, particularly advanced secondary school teachers (Pozas et al., 2020). In secondary education, Smale-Jacobse et al. (2019) found surprisingly few studies on the efficacy of DI.

Examining how DI affects students' mathematical success in secondary school is imperative (Muthomi & Mbugua, 2014). The adoption of DI in mathematics for elementary school students has been the subject of numerous studies (Ismajli & Imami-Morina, 2018; Mainini & Banes, 2017; Prast et al., 2018). However, there are few studies about DI in senior high school, especially in mathematics.

This study uses DI strategies such as prior knowledge assessment, open questions, parallel activities, and technology integration to address the student's mathematical disengagement and low mathematics performance. Additionally, it fills a gap in the literature on increasing higher secondary students' engagement in mathematics, which will improve their mathematics performance. This study may also help other researchers understand what additional DI-related topics they should consider.

Theoretical and Conceptual Framework

The study leaned on Greg Kearsley and Ben Schneiderman's engagement theory of learning. The learner gets genuinely engaged in class activities through interaction with other students and valuable work (Malik, 2021). By linking the material to the students, developing their creativity through various learning opportunities, encouraging cooperation, and incorporating technology in the classroom, the teacher can get the students interested in their studies. The above ideas were combined with DI strategies to improve student mathematics performance and engagement. However, the study relied heavily on the Edward Deming and Walter Shewhart concept of the plan-do-study-act model, as shown in Figure 1. Taylor et al. (2014) claimed that this model is frequently applied in school action research projects, guiding researchers through planned steps.

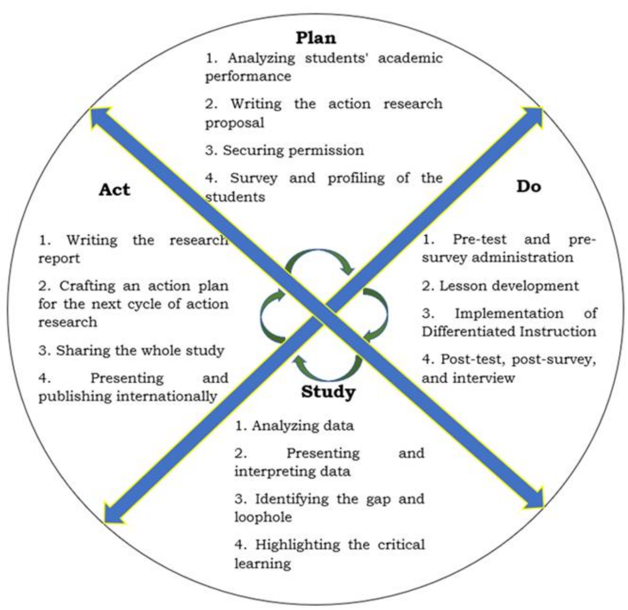

Figure 1. Study's Framework

The teacher identified the least learned competencies in the first grading period by analyzing the student's mathematics performance in periodic assessments and outputs in performance activities during the planning phase. The next step was to create a research proposal. The school principal was then given the approval for the whole study to be carried out. The researcher conducted a straightforward survey to identify the main reason for the subpar performance and sought suggestions for potential remedies. Additionally, the students were profiled based on their interests, learning styles, and intelligence. The study did not consider readiness because the students took two years of distance learning. The researchers assumed individuals needed greater readiness for face-to-face interaction because of the learning gap.

The pre-survey and pre-test of the do phase were used to gauge the students' prior engagement and mathematical knowledge. The principles and strategies of differentiated instruction were considered when creating lesson plans. The third grading period for the implementation lasted for two months. Following that, a post-survey, post-test, and interview were undertaken. Both qualitative and quantitative data analyses were done during the study phase. Hence, the engagement theory informed the presentation and data interpretation. The study's flaws and gaps were found to improve the intervention, and essential lessons were highlighted.

The act phase involved writing a research report and creating an action plan for the subsequent cycle. Studies were shared during faculty meetings and learning action cell (LAC) meetings. The work will be presented at conferences worldwide and published in a reputable online journal.

Research Questions

This study aimed to increase secondary students' mathematics performance and mathematical engagement through differentiated instruction. Specifically, it is intended to illuminate the following questions: 1. What is the student's level of mathematical engagement before and after the differentiated instruction implementation regarding behavioral, cognitive, emotional, and social aspects? 2. What is the students' mathematics performance in terms of their pre-test and post-test scores? 3. Does differentiated instruction effectively increase students' mathematics performance and mathematical engagement? 4. How does differentiated instruction boost students' performance and engagement in mathematics? 5. What suggested courses of action can be proposed in light of the study's findings to enhance student mathematical engagement and mathematics performance?

METHODOLOGY

Research Design

Practical action research was used to design the study. The goal was to get students more interested in mathematics and help them improve in school by using DI strategies like assessing their previous knowledge, open questions, parallel tasks, and integrating technology tools. By leveraging innovations or interventions, practical action research addresses local problems quickly (Chen & Lin, 2019). Practical action research is the applied study of localized and practical settings done by practitioners focusing on solving an identified problem (Mertler, 2021). Teachers addressed issues in the classroom through action research, such as student disengagement and subpar mathematics performance. However, only a few studies on DI use action research to examine the DI's efficacy, with most DI studies using a case study design (Bondie & Dahnke, 2019). Therefore, adopting an action research methodology is necessary to examine how DI strategies affect students' learning.

Participants

Students in four sections of Grade 11 Humanities and Social Sciences (HUMSS) at San Pedro Relocation Center National High School-Main in Laguna, Philippines for school year 2022-2023, participated in the study. Participants were senior high school students because, according to Domingo (2021), secondary students' response to DI was significantly greater than that of elementary pupils. Additionally, the latter needed assistance in acquiring mathematics with different characteristics. Despite being on the academic track, the four sections with 160 students were explicitly selected due to their lower interest in mathematics classes. Consequently, the group mentioned above comprises students aged 17 to 19 with various learning interests, preferences, and varied intelligence. Many students struggling with mathematics called for differentiated instruction to promote fair and inclusive mathematics education (Gervasoni et al., 2021). In addition, purposive sampling was utilized to choose the study's target participants based on their mathematics performance and engagement levels. Participants in the HUMSS were those students who were having mathematics difficulties. However, there is a need for more research using secondary students as participants in DI (Bondie & Dahnke, 2019), especially in mathematics disciplines.

Instrumentation

The study's research instruments for data collection included self-reported survey questionnaires, test material, and an interview guide. Due to its usefulness and simplicity, the self-report approach of gathering data through a questionnaire was frequently utilized. According to Fredricks & McColskey (2012), the self-report approach to gauging student engagement is accurate. In addition, the researchers chose to conduct interviews to confirm the results because it is possible that student respondents still need to provide sincere answers. It was preferable to gather qualitative data that precisely reflects experiences connected to student engagement, even though only some research uses interview approaches to describe student engagement (Deng et al., 2020). The qualitative approach made it easier to explain how a student becomes interested and how engagement changes over time (Fredricks & McColskey, 2012). The researchers support using various data collection techniques to refute Bondie and Dahnke's (2019) assertion that prior studies on DI had insufficient methodological rigor to examine its beneficial effects on student mathematics performance.

The first survey questionnaire was utilized to profile the students' interests and learning styles, including multiple intelligences as per McKenzie (2017), interests as per Shumow & Schmidt (2013), and learning styles as per Reid (2005). While the second survey questionnaire elicited demographic questions—which can include names, sections, ages, and sexes—were modified versions of those in Wang et al. (2016), Fredricks et al. (2016), and Burch et al. (2015), including questions about participants' mathematical engagement in terms of cognitive, behavioral, emotional, and social aspect. As a result, the authors received a letter of permission to use the specified instruments. On the other hand, teacher-made test materials included a 50-item pre- and post-test to gauge students' past and gained mathematics skills. The curriculum guide for Statistics and Probability served as the basis for the test construction.

The three research instruments underwent content validation as the first step in instrument creation (Halek et al., 2017). The subject-matter experts validated the content by considering each item on the research instrument (Ismail & Zubairi, 2022). The opinions of subject matter experts support each item's accuracy, accountability, and appropriateness as part of the instrument material. The master teacher, head teacher, senior education program specialist, and supervisor of the mathematics education program approved the instruments for content validity. The modification strictly adhered to the suggestions, which included correct grammar, proper punctuation and diction, a Filipino translation of each item, proportionate spacing, clear instructions, and the proper order of items. After that, the validators received the second iteration of the instruments for their approval.

After verifying the content validity, the test items and questionnaires were tested on non-participants since the researcher developed them and modified them from related studies. Fifty respondents participated in a pilot study of the survey questionnaire to determine the reliability indices for the four variables. As a result, reliability indices were calculated using Kuder-Richardson Formula 20 and Cronbach's alpha. Similarly, 20 non-participants participated in the pilot interviews to evaluate the precision and coherence of each interview question before data collection.

The pilot testing of the test material was administered to 50 non-participants to gather data for reliability using Kuder-Richardson Formula 20. The dependability of the test material is 0.87. The test material was then used for the HUMSS students' pre-test, and the results were saved for later comparison. Therefore, a comparable test material was used two months after the adoption of DI strategies. On the other hand, the questionnaire has reliability indices of .802, .809, .862, and .772 for the four variables under student engagement. Onyefulu and Roofe (2019) proposed a Cronbach's alpha acceptable value of 0.7 or above, indicating one variable's positive item correlation. Therefore, a questionnaire has good content validity and reliability characteristics (Cristobal & Cristobal, 2017).

Data Collection

The school head permitted the researchers to start the study in November 2022. The procedure required two weeks of pilot testing of the research tools and intervention on non-participants in January 2023. The revision took into account the main takeaways from the pilot testing. The fourth week of January 2023 saw the distribution of profiling survey questionnaires to the student participants to ascertain their learning interests, types of intelligence, and learning profiles. The second week of February 2023 saw the administration of a pre-survey and a pre-test exam to gauge the students' prior engagement with and knowledge of mathematics. The outcome was saved for comparison in the future, and the third grading period included a two-month differentiated instruction strategy implementation. In the third week of April 2023, a post-test was given to gauge the impact of the DI strategies.

In the final week of April 2023, post-surveys on participants and pilot interviews with non-participants were undertaken. Thus, to prevent biases and influence over the student participants, the student teacher interviewed 28 participants during the first week of May 2023 to collect qualitative data to corroborate the quantitative findings. Member checking was done in the second week of May 2023 to establish the truthfulness of the qualitative responses.

For the positionality statement, the first researcher collaborated with the student participant in charge of creating the study tools, data analysis, and report. He thought teaching should take into account the students' diverse learning preferences. On the other hand, the second researcher used DI strategies with the participants and administered test materials and survey questionnaires. She thought that every student learned differently. Hence, personal biases, such as opinions, were disregarded and bracketed to prevent data contamination and ensure the study's objectivity. Student teachers were hired to conduct the interviews to obtain accurate and correct answers from the student participants while avoiding bias. The student-teachers needed to gain knowledge of DI strategies and had no connection to the participants. Twenty-eight HUMSS participants were interviewed, and the survey and test materials were given out twice over two months.

Ethical Considerations

The protocol for every research project must include ethical issues (Astaneh & Masoumi, 2018; Stockemer, 2019). Therefore, authorization from the school was requested, and consent from the parents was obtained by writing a formal letter requesting their approval. The questionnaire's authors received an email from the researchers requesting their permission to use the surveys. On the other hand, participants could withdraw their participation at any time without penalty. Participants who were students did not earn anything in return for their participation. However, the identity of the participants was kept secret to safeguard them from potential danger, and the data were handled with the highest discretion. Additionally, the research report and data were kept on the researchers' computers for two years before being erased. The research report was also presented at faculty gatherings, conferences, and journal publication.

Data Analysis

The study used quantitative data treatment, including Cronbach's alpha for internal consistency, mean and median for description, Shapiro-Wilk to test for data normality, and Levene's test for variance homogeneity. Also, the Wilcoxon Signed-Rank Test was used to determine whether there was a statistical difference in students' levels of engagement and mathematics performance before and after the DI implementation, and the Rosenthal correlation coefficient (r) was computed to determine the effect size. The effect size was highly significant when a pre-test and post-test design was employed to study the impact of DI (Domingo, 2021). The study utilized the Statistical Package for the Social Sciences (SPSS) version 23 for computing, while manual coding was done for the thematic analysis of qualitative data. The Rosenthal correlation coefficient (r), which measures the effect size (Fritz et al., 2012; Mangiafico, 2016; Simone, 2017), was calculated in MS Excel using the standardized score ratio to the sample size's square root.

Thematic analysis was utilized to summarize qualitative data into patterns or concepts characterized by themes (Castleberry & Nolen, 2018). Thematic analysis is the most common way of analyzing qualitative data obtained from the interview (Kiger & Varpio, 2020). The researchers used a collaborative, iterative data analysis process to arrive at the correct data by checking the codes into categories to remove potential biases. Additionally, member checking was utilized to confirm the validity of the qualitative results (Birt et al., 2016). Inquiring about the participants' agreement with the conclusions and the accuracy of the data, the participants received the data and their interpretation back to ensure the data accuracy (Candela, 2019).

Table 1 shows tests for normality and the homogeneity of variances as a precondition for employing inferential statistics (Hanusz & Tarasińska, 2015). Since the data are ordinal and do not approximate a normal curve, the non-parametric test of difference was applied for the results of pre- and post-survey. The data were not normally distributed according to the significant values from Shapiro-Wilk tests (p<.05) as the most common normality test (Horváth et al., 2020). However, all post-test scores exceeded the significance level of .05 alpha. On the other hand, the value of Levene's test suggests that the variances are homogeneous, except for the post-test scores. The following table supports the need for a non-parametric test of difference rather than a parametric test that demands data normality (Grech & Calleja, 2018).

Table 1. Levene's Test Results and Shapiro-Wilk Test Results of the Level of Engagement in the Questionnaire and Test Scores

		Levene's test				Shapiro-Wilk		
	Variable	**Statistic**	**df_1**	**df_2**	**Sig.**	**Statistic**	**df**	**Sig.**
Pre-survey	Behavioral	.624	3	156	.600	.957	160	.000
	Cognitive	.063	3	156	.979	.967	160	.001
	Emotional	.819	3	156	.485	.962	160	.000
	Social	.295	3	156	.829	.938	160	.000
Post-survey	Behavioral	.145	3	156	.933	.975	160	.005
	Cognitive	.640	3	156	.590	.957	160	.000
	Emotional	.695	3	156	.557	.972	160	.002
	Social	.235	3	156	.872	.959	160	.000
Examination	Pre-test	.237	3	156	.871	.978	160	.011
	Post-test	5.186	3	156	.002	.955	160	.000

RESULTS

Table 2 shows the participants' behavioral engagement before and after applying the DI-based lessons. Before implementation, students showed low behavioral engagement by paying less attention in math class, not completing their homework and assignments after the deadline, and speaking less about math outside of the classroom. However, with implementation, these went up. At some point, individuals engaged in very high levels of behavior, such as actively wanting to study and contributing to class debates on math. The student's high level of behavioral engagement was crucial in determining how passionately they felt about learning mathematics, yielding better mathematics achievement from higher behavioral engagement (Wang et al., 2016). It indicates that after the application of DI strategies, behavioral engagement increased.

Table 3 shows the level of cognitive engagement before and after using differentiated instruction strategies. Before the implementation of DI strategies, students' cognitive mathematical engagement was low, as seen in their inability to make connections between prior learning experiences and current lessons, their difficulty coming up with original solutions for math problems, their lack of confidence in their ability to check their work for accuracy, their lack of study of the more challenging aspects of math activities, and their perception that math is difficult to do in a class. After the implementation, however, students exhibit high levels of mathematical cognitive engagement. They can consider several approaches to solving math problems, analyze the activity, and ensure the mathematical task is done correctly similar to the findings of Wang et al. (2016). Because of this, there was a very high level of cognitive engagement following the application of DI strategies, including connecting previous lessons to new lessons and performing math beyond expectations supporting Greene's findings (2015). Supporting the findings of Katzi et al. (2013), DI significantly improved student engagement and cognitive abilities.

Table 2. Behavioral Engagement of the Participants Before and After the Differentiated Instruction Strategies Implementation

Statement	Before			After		
	Median	**IQR**	**VI**	**Median**	**IQR**	**VI**
1. I remain focused in my math class.	2	1	low	3	1	high
2. I put more effort into learning math.	3	1	high	3	1	high
3. I am trying to learn math, even if it is hard.	3	1	high	4	1	very high
4. I do my homework and activities in math on time.	2	1	low	3	1	high
5. I actively participate in class discussions in math class.	3	0	high	4	0	very high
6. I try to learn more in math.	3	1	high	3	1	high
7. I talk about math even outside school.	2	1	low	3	1	high

Legend: IQR = Interquartile Range VI = Verbal Interpretation

Table 3. Cognitive Engagement of the Participants Before and After the Differentiated Instruction Strategies Implementation

Statement	Before			After		
	Median	**IQR**	**VI**	**Median**	**IQR**	**VI**
1. I go through the math classwork and ensure it is correct.	2	0	low	3	0	high
2. I can solve math problems differently.	2	0	low	3	0	high
3. I connect my previous learning with the present math lessons.	3	1	low	4	0	very high
4. I try to understand my errors in math when I make mistakes.	3	1	high	3	1	high
5. When math activity is challenging, I study all the parts.	2	1	low	3	0	high
6. My math lesson becomes easy in my class.	2	1	low	3	0	high
7. I do math activities more than what is required in class.	3	1	high	4	1	very high

Legend: IQR = Interquartile Range V I = Verbal Interpretation

Table 4 depicts the emotional engagement before and after applying differentiated instruction strategies. It demonstrates that previous students were less emotionally engaged, as evidenced by their lower enjoyment of learning new material and negative feelings about math class and learning new material. However, with the application of DI strategies, students experienced high levels of emotional engagement, including enjoyment of new lessons, feeling good in class, and feeling fantastic about studying mathematics. As a result, individuals exhibit very high emotional engagement, such as continuing to attend and enjoy math class similar to the finding of Ansonga et al. (2017).

Table 4. Emotional Engagement of the Participants Before and After the Differentiated Instruction Strategies Implementation

Statement	Before			After		
	Median	IQR	VI	Median	IQR	VI
1. I love learning new lessons about math.	2	1	low	3	0	high
2. I am eager to learn more about math lessons.	3	1	high	3	0	high
3. I feel motivated when I am attending a math class.	2	0	low	3	0	high
4. My math class is enjoyable.	3	0	high	3	0	very high
5. I want to stay in my math class.	3	1	high	4	1	very high
6. I feel great when I learn new math lessons.	2	1	low	3	1	high
7. I look forward to math class.	3	1	high	3	1	high

Legend: IQR = Interquartile Range V I = Verbal Interpretation

Table 5 compares social engagement using the median before and after the use of the differentiated instruction strategies. Before, students only cared a little about, tried to grasp the mathematical ideas of others or collaborate with others when doing math-related activities. However, upon implementation, students exhibit high levels of social engagement, such as comprehending others' mathematical concepts, exchanging ideas while working with others, assisting math-struggling peers, and participating in group activities. According to Kiefer & Ryan (2011) and Wang and Eccles (2013), having positive interpersonal ties in the classroom results in great mathematics success. As a result, they actively seek out and engage in social activities such as teamwork and collaboration. These were made clear during group activities where the teacher asked the students to create various group products, such as songs, dances, poems, or real-world applications of their learned mathematical ideas. Better student engagement at DI increased their learning capacity (Wilujeng, 2012).

Table 5. Social Engagement of the Participants Before and After the Differentiated Instruction Strategies Implementation

Statement	Before			After		
	Median	IQR	VI	Median	IQR	VI
1. I care about other peoples' ideas in math.	2	1	low	3	1	high
2. I try to comprehend my classmates' mathematical ideas.	2	1	low	3	1	high
3. I enjoy working in a group that can help me.	3	1	high	4	1	very high
4. I share my ideas when working on math activities.	3	1	high	3	.75	high
5. I try to help my struggling classmate in math class.	3	0	high	3	0	high
6. I enjoy having group activities more than doing them alone.	3	1	high	3	0	high
7. I enjoy with others while doing math activities.	2	1	low	4	0	very high

Legend: IQR = Interquartile Range V I = Verbal Interpretation

Table 6 shows the descriptive statistics of the pre-test and post-test results. The pre-test scores range from 9 to 27, with a mean of 15.79 and a standard deviation of 3.63, manifesting that the students have low prior knowledge of the 3rd quarter lessons. However, the post-test scores range from 12 to 43 with a mean of 24.47 and a standard deviation of 7.64, manifesting that the students have gained knowledge of the lessons for the 3rd quarter after implementing DI strategies. Through DI strategies, high mathematics performance was gained as a result of positive student interactions supporting the findings of Wang and Eccles (2013).

Table 6. Descriptive of the Pre-test and the Post-test Scores

Test	Minimum score	Maximum score	Mean	SD
Pre-test	9	27	15.79	3.63
Post-test	12	43	24.47	7.64

Table 7 depicts the Wilcoxon Signed-Rank Test's result for the significant difference before and after using differentiated instruction. The computed value of - 9.957 (p=.000) indicates that the post-test scores are significantly different from the pre-test scores, which indicates that the post-test scores are highly different compared to the pre-test scores, consistent with Morallos's (2018) findings. DI strategies enhanced mathematics achievement supporting Muthomi and Mbugua's findings (2014) It supports the usefulness of using DI strategies to increase students' academic achievement, in line with the findings of Chen and Chen (2018), Özer and Yılmaz (2018), and Valiandes and Neophytou (2018).

The student engagement levels in mathematics are also significantly different before and after the DI instruction. The Wilcoxon Signed-Rank test's p-value of .000, less than the .05 significance level, clearly demonstrates that the medians before and after were statistically different. It implies that DI strategies enhanced secondary student mathematical engagement because their cognitive, behavioral, emotional, and social engagement in mathematics increased. More engaged students attend class more frequently, resulting in more incredible mathematics performance than less engaged students (Bear et al., 2018). Therefore, teachers must develop measures to increase student engagement to ensure higher student performance. In terms of effect size, DI strategies have a substantial impact on mathematics performance and behavioral, cognitive, and social engagement but a moderate impact on emotional engagement. DI strategies positively impacted students' mathematics performance and mathematical engagement. So, it is essential to maintain DI strategies while teaching.

Table 7. Rosenthal Correlation Coefficient r for Effect size and Wilcoxon Signed-Rank Test for Significant Difference Before and After the Implementation of Differentiated Instruction

Paired	Variable	Computed value	p-value	Interpretation	r	Interpretation
Pre-test vs. Post-test	Scores	-9.957	.000	Highly Significant	-781	Strong
Pre-survey vs. Post-survey	Behavioral	-10.056	.000	Highly Significant	-.787	Strong
	Cognitive	-7.182	.000	Highly Significant	-.795	Strong
	Emotional	-7.918	.000	Highly Significant	-.568	Moderate
	Social	-9.879	.000	Highly Significant	-.626	Strong

Figure 2 shows how the DI strategies increase student mathematical engagement. It demonstrates how the students increased their enthusiasm for learning math topics by using DI strategies. The teachers' adoption of instructional strategies challenged the students to actively participate in learning lessons that align with Yavuz's (2020) findings encourages them to think logically. Additionally, because the lessons considered their learning preferences and styles, students fully comprehended the mathematics subject. Additionally, because they had experience cooperating in groups, they felt comfortable enough to participate in the activities. Given a chance to express their ideas and perform freely, students could collaborate and contribute through brainstorming.

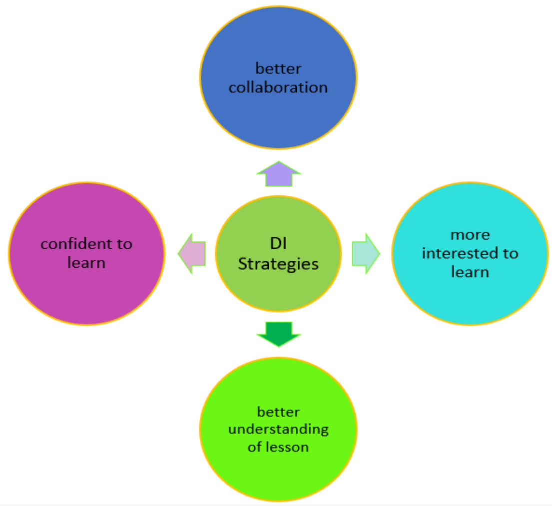

Figure 2. How the DI Strategies Improved the Student Mathematical Engagement

The findings above are supported by the participants' interview excerpts.

"I was more engaged in answering because I understood the lessons better because our math subject is easier for me." Participant 3

"I became more confident, especially when the ones being taught showed more interest in me." Participant 12

Figure 3 shows how DI strategies affect students' mathematics performance. Students could concentrate on their lessons while applying the DI strategies, taking notes precisely, and paying attention to their mathematics teacher engagingly. The ability to express their opinions, inventiveness, and passion while participating in the activity without fear of making mistakes also helped students feel confident. They eventually had various opportunities to indicate their learning preferences (Say & Emir, 2017), and they demonstrated their desire and persistence to learn more.

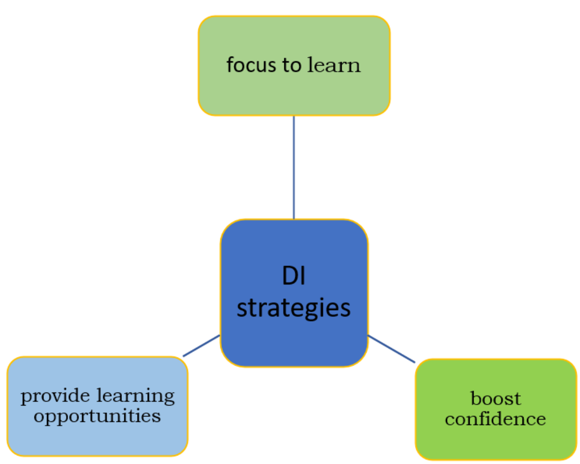

Figure 3. How the DI Strategies Improved the Students' Mathematics Performance

The findings above are supported by the participants' interview excerpts.

"My confidence is getting stronger now that I can answer. I used to think I might be laughed at when I answered wrongly, but with our teacher, it is okay even if your answer is wrong as long as you try to answer the question. Participant 8

"In my teacher's way, we enjoy understanding more. There is fear, but we enjoy understanding more about what math is, what the real meaning of math is, and that it is not just to torture us but to make us learn." Participant 22

Figure 4 outlines the steps to take to maintain the student's interest in mathematics and their growth in mathematics performance. The most crucial first step in learning about the characteristics of the students is the student profile, which serves as the foundation for creating the lesson and learning opportunities. Teachers must create various learning opportunities based on student preferences to accommodate individual differences. Additionally, it is essential to consider student feedback when modifying DI strategies and learning activities to promote mathematical engagement and mathematics success.

Figure 4. Courses of Action to Sustain Students' Mathematics Performance and Mathematical Engagement

DISCUSSION

The mathematics teacher acknowledged that her DI practices were not flawless because some flaws were discovered upon reflection, such as the fact that the students were only given a limited amount of time to complete group activities, that they preferred to form groups with other bright students, and that there were few student products produced. Therefore, she intends to often develop diverse activities for distinct student types during the subsequent DI deployment to address various learning preferences. These give students the chance to participate in various math-class learning activities. Additionally, she plans to develop a variety of energizing exercises that let the students switch between groups while working on group activities and incorporate journal writing into the class. In addition, DI strategies will be used for a considerable amount of time to determine how well they maintain students' learning interests and enthusiasm for mathematics.

Behavioral, cognitive, emotional, and social engagement with mathematics impacts students' motivation to learn the lesson. Secondary students were able to raise this level due to DI strategies. Students could use their learned skills in various ways, which helped struggling students collaborate and perform better. The student' mathematical engagement was essential to their ability to perform mathematically. Therefore, the mathematics teacher may continue working to sustain student engagement for the entire school year because motivated learners are more eager to attend class and get higher grades (Bear et al., 2018). Making every learning session pleasant, including relevant experiences, kindling the student's love for learning, and modifying the teaching episode based on the student's learning needs are all important ways the mathematics teacher can increase student engagement (Pedler et al., 2020). To accommodate student diversity, the mathematics teacher may incorporate DI strategies into lesson planning (Luistro, 2016). Implementing DI in the classroom is essential in support of the National Council of Teachers of Mathematics (NCTM) call for it (Smith et al., 2018).

According to the engagement theory, students are more engaged in their learning activities when their interests and learning preferences are considered when developing the lessons (Alrajeh & Shindel, 2020). They can also express their creativity, passions, and expressions through collaborative work. Therefore, engagement increases if various activities are provided to students that call for various skills, enhancing their ability to contribute despite their individuality and variety of learning preferences. Through DI, teachers provide students the chance to express their diversity and to succeed according to their personal preferences. As a result of the correlation between the two factors, student mathematical engagement and exam performance improve (Wang et al., 2016). DI improves students' mathematics abilities since engaged students outperform non-engaged students academically (Geel et al., 2022). Therefore, to maintain students' enthusiasm for learning, mathematics teachers may use interventions or strategies that spark student engagement.

CONCLUSIONS AND RECOMMENDATIONS

The behavioral, cognitive, emotional, and social levels of mathematics engagement among secondary students were low before the DI implementation, but they increased afterward. It implies that DI enhanced students' cognitive, behavioral, emotional, and social engagement in mathematics. Also, the pre-test and post-test scores were also considerably different, supporting the claim that DI strategies successfully raised the student's mathematics performance on the exam. Through DI, students gain the confidence to collaborate with others and comprehend the lessons better. They develop tremendous enthusiasm for learning and active participation in group activities. Students can enhance their focus on their studies by taking meticulous notes, and actively engaging with their mathematics teacher. Their confidence was bolstered by their capacity to freely voice their thoughts, demonstrate originality, and showcase their passion, without any apprehension of making errors.

In line with these findings, the mathematics teacher may constantly employ DI strategies to enhance the students' mathematical engagement, subsequently improving their mathematics achievement. When designing lesson activities, mathematics teachers may take previous assessments into account. They may also incorporate open questions to encourage students to think critically. They may use parallel tasks during group activities to address the learning needs of the students' various problem-solving skills. Then, they may use technology to make the lesson efficient and engaging. Finally, they may use various assessment methods to highlight the students' creativity and expressiveness.

Since this was practical action research only implemented for two months, the study was only conducted at one school. It is strongly advised that a future study consider the experiences of students and teachers in adopting DI strategies in different schools with more extended implementation periods. Future scholars may also examine what influences students' interest and mathematics success. When creating differentiated lessons, student readiness may be considered in addition to learning profiles and interests. Moreover, mathematics teachers may consistently implement DI strategies to keep students interested in and passionate about learning.

IMPLICATIONS

The study justified the benefits of DI strategies in mathematics classes. So, teachers may apply various DI strategies to cater to diverse learning needs by considering the student learning styles and preferences. Mathematics teachers have to create inclusive learning environments that engage students behaviorally, cognitively, emotionally, and socially. Similarly, by acknowledging the student's unique learning need, mathematical engagement and performance increase. Therefore, DI breaks the barrier to active and inclusive learning, making mathematics enjoyable, relevant, and engaging (Yavuz, 2020). However, regular assessment of the impact of DI strategies through student feedback is needed to make the necessary adjustments to improve the student learning experience.

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DECLARATIONS

Conflict of Interest

No conflict of interest was declared by all authors in publishing the paper.

Informed Consent

Informed consent was secured before the conduct of the study as part of the protocol by sending formal letters to the parents and participants.

Ethics Approval

The school governing body approved the proposal and the process of the research project.

REFERENCES

Alrajeh, T. S., & Shindel, B. W. (2020). Student engagement and math teachers support. *Journal on Mathematics Education, 11*(2), 167-180. http://doi.org/10.22342/jme.11.2.10282.167-180

Ansonga, D., Okumub, M., Bowena, G., Walkera, A., & Eisensmitha, S. (2017). The role of parent, classmate, and teacher support in student engagement: Evidence from Ghana. *International Journal of Educational Development, 54*, 51–58. https://doi.org/10.1016/j.ijedudev.2017.03.010

Astaneh, B., & Masoumi, S. (2018). From paper to practice: Indexing systems and ethical standards. *Science and Engineering Ethics, 24*, 647–654. https://doi.org/10.1007/s11948-017-9899-x

Bear, G.G., Yang, C., Chen, D., He, X., Xie, J.S., & Huang, X. (2018). Differences in school climate and student engagement in China and the United States. *School Psychology Quarterly, 33*(2), 323-335. http://dx.doi.org/10.1037/spq0000247

Bondie, R., & Dahnke, C. (2019). How Does Changing "One-Size-Fits-All" to Differentiated Instruction Affect Teaching? *Review of Research in Education, 43*, 336-362. https://doi.org/10.3102/0091732X18821130

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: a tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, 26(13), 1802-1811. https://doi.org/10.1177/1049732316654870

Burch, G., Heller, N., Burch, J., Freed, R., & Steed, S. (2015). Student engagement: Developing a conceptual framework and survey instrument. Journal of Education For Business, 90, 224–229. https://doi.org/10.1080/08832323.2015.1019821

Candela, A. G. (2019). Exploring the function of member checking. *The Qualitative Report, 24*(3), 619-628. https://nsuworks.nova.edu/tqr/vol24/iss3/14

Castleberry, A., & Nolen, A. (2018). Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning, 10*(6), 807-815. https://doi.org/10.1016/j.cptl.2018.03.019

Chen, J. H., & Chen, Y.-C. (2018). Differentiated instruction in a Calculus curriculum for college students in Taiwan. *Journal of Education and Learning, 7*(1), 88-95. https://doi.org/10.5539/jel.v7n1p88

Chen, CS., & Lin, JW. (2019). A practical action research study of the impact of maker-centered STEM-PjBL on a rural middle school in Taiwan. *International Journal of Science and Mathematics Education*, 17 (1), 85–108. https://doi.org/10.1007/s10763-019-09961-8

Chiner, E., & Cardona, M. (2013). Inclusive education in Spain: How do skills, resources, and supports affect regular education teachers' perceptions of inclusion? *International Journal of Inclusive Education, 17* (5), 526–41. https://doi.org/10.1080/13603116.2012.689864

Cristobal, A., & Cristobal, M. (2017). *Research made easier: A step by step process*. C & E Publishing, Inc.

Deng, R., Benckendorff, P., & Gannaway, D. (2020). Learner engagement in MOOCs: Scale development and validation. *British Journal of Educational Technology, 51(1)*, 245-262. https://doi.org/10.1111/bjet.12810

DepEd Order No. 021, s. 2019. *Policy guidelines on the K to 12 basic education program*. https://www.deped.gov.ph/wp-content/uploads/2019/08/DO_s2019_021.pdf

DepEd Order No. 035, s. 2016. T*he learning action cell as a K to 12 basic education program school-based continuing professional development strategy for the improvement of teaching and learning.* https://www.deped.gov.ph/wp-content/uploads/2016/06/DO_s2016_035.pdf

Domingo, J. A. (2021). *Meta-analysis on the effect of differentiated instruction on students' mathematics achievement*. (Master's thesis). Philippine Normal University.

Fogarty, J. R., & Pete, M. B. (2017). *Supporting differentiated instruction: A professional learning communities approach*. Bloomington, NJ: Solution Tree Press.

Fredricks, J. A., & McColskey,W. (2012). The measurement of student engagement: A comparative analysis of various methods and student self-report instruments. In S. Christenson, A. L. Reschy, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 319-339). New York: Springer.

Fredricks, J. A., Wang, M. T., Schall Linn, J., Hofkens, T. L., Sung, H., Parr, A., & Allerton, J. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction, 43*, 5-15. https://doi.org/10.1016/j.learninstruc.2016.01.009

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology: General, 141*(1), 2–18. https://doi.org/10.1037/a0024338

Geel, M, Keuning, T., & Safar,I. (2022). How teachers develop skills for implementing differentiated instruction: Helpful and hindering factors. *Teaching and Teacher Education: Leadership and Professional Development,1,* https://doi.org/10.1016/j.tatelp.2022.100007

Gervasoni, A., Downton, A., & Roche, A. (2021). Differentiating instruction for students who fail to thrive in mathematics: the impact of a constructivist-based intervention approach. *Mathematics Teacher Education and Development, 23*(3), 207-233. https://files.eric.ed.gov/fulltext/EJ1321054.pdf

Grech, V., & Calleja, N. (2018). WASP (Write a Scientific Paper): Parametric vs. non-parametric tests. *Early Human Development, 123*, 48-49. https://doi.org/10.1016/j.earlhumdev.2018.04.014

Greene, B. A. (2015). Measuring cognitive engagement with self-report scales: Reflections over 20 years of research. *Educational Psychologist, 50(1)*, 14-30. https://doi.org/10.1080/00461520.2014.989230

Halek, M., Holle, D., & Bartholomeyczik, S. (2017). Development and evaluation of the content validity, practicability and feasibility of the innovative dementia-oriented assessment system for challenging behavior in residents with dementia. *BMC Health Services Research, 17*(1), 554. https://doi.org/10.1186/s12913-017-2469-8

Hanusz, Z., & Tarasińska, J. (2015). Normalization of the Kolmogorov–Smirnov and Shapiro–Wilk tests of normality. *Biometrical Letters, 52*(2), 85–93. https://doi.org/10.1515/bile-2015-0008

Horváth, L., Kokoszka, P., & Wang, S. (2020). Testing normality of data on a multivariate grid. *Journal of Multivariate Analysis, 179*, 104640. https://doi.org/10.1016/j.jmva.2020.104640

Ismail, F. K., & Zubairi, A. M. (2022). Item objective congruence analysis for multi-dimensional items content validation of a reading test in Sri Lankan University. *English Language Teaching, 15*(1), 106-117. https://doi.org/10.5539/elt.v15n1p106

Ismajli, H., & Imami-Morina, I. (2018). Differentiated instruction: Understanding and applying interactive strategies to meet the needs of all the students. *International Journal of Instruction, 11*(3), 207-218. https://doi.org/10.12973/iji.2018.11315a

Katzi, P., Tsolaki, E., Mavrotheris, M., & Koutselini. M (2013): Differentiation of teaching and learning mathematics: an action research study in tertiary education, *International Journal of Mathematical Education in Science and Technology, 44*(3), 332-349. http://dx.doi.org/10.1080/0020739X.2012.714491

Kiefer, S. M., & Ryan, A. M. (2011). What characteristics are associated with social success?

Changes in students' perceptions of social success during early adolescence. *Applied Developmental Psychology,* 32(4), 218-226. https://doi.org/10.1016/j.appdev.2011.05.002

Kiger, M., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher*, 846-854. https://doi.org/10.1080/0142159X.2020.1755030

Luistro, A. A. (2016). Policy guidelines on daily lesson preparation for the K to 12 Basic Education Program. *DepEd, 42* (2016), 1-62. https://www.deped.gov.ph/2016/06/17/do-42-s-2016-policy-guidelines-on-daily-lesson-preparation-for-the-k-to-12-basic-education-program/

Mainini, M., & Banes, L. (2017). Differentiating instruction to increase conceptual understanding and engagement in mathematics. *The Journal of Teacher Action Research,* 4(1), 81-100. http://www.practicalteacherresearch.com/uploads/5/6/2/4/56249715/differentiating_instruction_to_increase_conceptual_understanding_and_engagement_in_mathematics.pdf

Malik, C. (2021). Engagement Theory of Learning: An Overview. https://www.selfcad.com/blog/engagement-theory-of-learning-an-overview

Mangiafico, S. S. (2016). Summary and analysis of extension*. Program evaluation in R. 1(1).* Rutger Cooperative Extension.

Martin, A. J., Way, J., Bobis, J., & Anderson, J. (2015). Exploring the ups and downs of math engagement in the middle school years. *Journal of Early Adolescence, 35*(2), 199-244. https://doi.org/10.1177/0272431614529365

McKenzie, W. (2017). *Multiple Intelligences Inventory.* https://surfaquarium.com/MI/inventory.htm

Mertler, C. A. (2021). Action research as teacher inquiry: A viable strategy for resolving problems of practice. *Practical Assessment, Research, and Evaluation,* 26(19), 1-12. https://scholarworks.umass.edu/pare/vol26/iss1/19

Morallos, C. (2018). *Effects of differentiated instruction on achievement goals and performance in mathematics (Master's Thesis*). Philippine Normal University.

Morgan, H. (2014). Maximizing student success with differentiated learning. *The Clearing House House: A Journal of Educational Strategies, Issues and Ideas*, 87(1), 34–38. https://doi.org/10.1080/00098655.2013.832130

Muthomi. M., & Mbugua, Z. (2014). Effectiveness of differentiated instruction on secondary school students' achievement in mathematics. *International Journal of Applied Science and Technology, 4*(1), 116-122.

Naungayan, R. (2022). Attitude towards mathematics and mathematics achievement of secondary school learners in Banayoyo-Lidlidda District. *Puissant, 3*, 395-407. https://puissant.stepacademic.net/puissant/article/view/89

Onyefulu, C., & Roofe, C. (2019). Characteristics, technology capabilities, and experiences of in-service teachers on the use of online/blended learning at a tertiary institution in Jamaica. *Open Access Library Journal,* 6, e5147. https://doi.org/10.4236/oalib.1105147

Oribhabor, C. B. (2020). Evaluating the effect of activity-based method of teaching

mathematics on Nigerian secondary school students' achievement in mathematics. *Puissant – A Multidisciplinary Journal, 1*, 77-87. https://puissant.stepacademic.net/puissant/article/view/32
Özer, S., & Yılmaz, E. (2018). The effect of thinking-style-based differentiated instruction on achievement, attitude, and retention. *Kastamonu Education Journal, 26*(1), 11-20. http://dx.doi.org/10.24106/kefdergi.374145
Pedler, M., Yeigh, T., & Hudson, S. (2020). The teachers' role in student engagement: A review. *Australian Journal of Teacher Education, 45*(3), 48-62. http://dx.doi.org/10.14221/ajte.2020v45n3.4
Pozas, M., Letzel, V., & Schneider, C. (2020). Teachers and differentiated instruction: exploring differentiation practices to address student diversity. *Journal of Research in Special Educational Needs, 20*(3), 217–230. https://doi.org/10.1111/1471-3802.12481
Prast, E. J., Weijer-Bergsma, E. V., Kroesbergen, V., & Van Luit, J. (2018). Differentiated instruction in primary mathematics: Effects of teacher professional development on student achievement. *Learning and Instruction 54*, 22–34. https://doi.org/10.1016/j.learninstruc.2018.01.009
Prast, E. J., van de Weijer-Bergsma, E., Kroesbergena, E. H., & Van Luit, J. (2015). Readiness-based differentiation in primary school mathematics: Expert recommendations and teacher self-assessment. *Frontline Learning Research, 3* (2), 90–116. https://doi.org/10.14786/flr.v3i2.163
Republic Act No. 10533 (2013). *An act enhancing the Philippine basic education system by strengthening its curriculum and increasing the number of years for basic education, appropriating funds therefor and for other purposes*. https://www.officialgazette.gov.ph/2013/05/15/republic-act-no-10533/
Reschly, A. L., & Christenson, S. L. (2012). Jingle, jangle, and conceptual haziness: Evolution and future directions of the engagement construct. In S. L. Christenson, A. L. Reschly, & A. Wylie (Eds.), *Handbook of research on student engagement* (pp. 1-19). New York: Springer.
Reid, G. (2005). *Learning styles and inclusion.* https://epdf.tips/learning-styles-and-inclusion.html
Ritzema, E. S., Deunk, M. I., & Bosker, R. J. (2016). Differentiation practices in grade 2 and 3: variations in teacher behavior in mathematics and reading comprehension lessons. *Journal of Classroom Interaction, 51* (2), 49–71. https://www.jstor.org/stable/26446202
Roy, A., Guay, F., & Valois, P. (2013). Teaching to address diverse learning needs: Development and validation of a differentiated instruction scale. *International Journal of Inclusive Education 17*(11), 1186–1204. https://doi.org/10.1080/13603116.2012.743604
Ruzek, E.A., Hafen, C.A., Allen, J.P., Gregory, A., Mikami, A.Y., & Pianta, R. C. (2016). How teacher emotional support motivates students: The mediating roles of perceived peer relatedness, autonomy support, and competence. *Learning and Instruction, 42*, 95-103. https://doi.org/10.1016/j.learninstruc.2016.01.004
Sapan, M., & Mede, E. (2022). The effects of differentiated instruction (DI) on

achievement, motivation, and autonomy among English learners. I*ranian Journal of Language Teaching Research, 10*(1), 127-144. https://doi.org/10.30466/ijltr.2022.121125
Say, K. A., & Emir, S. (2017). The effects of differentiated foreign language instruction on academic achievement and creativity of gifted students. *International Journal of Academic Research, 5*(1), 276-288. https://files.eric.ed.gov/fulltext/ED582027.pdf
Shumow, L., & Schmidt, J. l. (2013). *Student interest inventory.* https://edwp.educ.msu.edu/research/wp-content/uploads/sites/10/2020/06/VALUE_StudentInterestInventory.pdf
Simone, A. (2017). *How do you calculate the effect size of one-sample Wilcoxon signed-rank test? Cross* Validated. https://stats.stackexchange.com/q/234454
Smale-Jacobse, A., Meijer, A., Helms-Lorenz, M., & Maulana, R. (2019). Differentiated instruction in secondary education: A systematic review of research evidence. *Frontiers in Psychology, 10*, 23-66. https://doi.org/10.3389/fpsyg.2019.02366
Smith, M., Bill, V., & Raith, M. L. (2018). Promoting a conceptual understanding of mathematics. Mathematics Teaching in the Middle School, 24(1), 36-43. https://doi.org/10.5951/mathteacmiddscho.24.1.0036
Stetson, R., Stetson, E., & Anderson, K. (2007). Differentiated instruction, from teacher's experiences. *School Administrator, 64*(8), 28.
Stockemer, D. (2019). Quantitative methods for the social sciences: A practical introduction with examples in SPSS and Stata. Springer. https://link.springer.com/book/10.1007/978-3-319-99118-4
Suprayogi, M. N., & Valcke, M. (2016). Differentiated instruction in primary schools: Implementation and challenges in Indonesia. *PONTE, 72*(6), 2-18. http://dx.doi.org/10.21506/j.ponte.2016.6.1
Taylor, M. J., McNicholas, C., Nicolay, C.; Darzi, A., Bell, D., & Reed, J. E. (2014). Systematic review of the application of the plan-do-study-act method to improve quality in healthcare. BMJ Quality & Safety, 23(4), 290–298. https://doi.org/10.1136/bmjqs-2013-001862
Tomlinson, C. A. (2014). *The differentiated classroom. Responding to the needs of all learners*, 2nd Edn. Association of Supervision and Curriculum Development.
Tuazon, A., & Torres, A. (2022). Predicting academic performance based on students' mathematics motivation. *Turkish Journal of Computer and Mathematics Education, 13*(2), 402-409. https://www.turcomat.org/index.php/turkbilmat/article/view/12262/8898
Valiandes, S., & Neophytou, L. (2018). Teachers' professional development for differentiated instruction in mixed-ability classrooms: investigating the impact of a development program on teachers' professional learning and students' achievement. *Teacher Development,* 22(1), 123-138. https://doi.org/10.1080/13664530.2017.1338196
Wang, M. T., Fredricks, J., Ye, F., Hofkens, T., & Linn, J. S. (2016). The math and science engagement scales: Scale development, validation, and psychometric properties. *Learning and Instruction, 43*, 16-23. https://doi.org/10.1016/j.learninstruc.2016.01.008
Wang, M. T., & Degol, J. (2014). Staying engaged: Knowledge and research needs in

student engagement. *Child Development Perspectives, 8*(3), 137-143. https://doi.org/10.1111/cdep.12073
Wang, M. T., & Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: a longitudinal study of school engagement using a multi-dimensional perspective. *Learning and Instruction, 28*, 12-23. https://doi.org/10.1016/j.learninstruc.2013.04.002
Wilujeng, N. C. S. (2012). The differentiated instruction and its implementation for developing countries: Partnership students learning Indonesian language in bridging course program. *Journal of Education,* 5(I), 49-52. https://doi.org/10.1109/ICEELI.2012.6360659
Yavuz, A. C. (2020). The effects of differentiated instruction on Turkish students' L2 achievement, and student and teacher perceptions. *Eurasian Journal of Applied Linguistics,* 6(2), 313-335. https://doi.org/10.32601/ejal.776002

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