

# Differentiated Mathematics Instruction in Jamaica: Educator Perspectives on Diverse Learning Needs

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**Abstract:** *This study explores teachers' use of differentiated instruction to improve mathematics performance among struggling learners and students with exceptionalities in Jamaica. Eight teachers from seven schools participated in this phenomenological research. Findings highlight the benefits of differentiated instruction despite challenges such as large class sizes, limited resources, and teacher workloads. Recommendations include specialized training and resource allocation to enhance instructional effectiveness.*

**Keywords:** differentiated instruction, exceptionalities, mathematics performance/ achievement, struggling learner, underperformance

## 1. Introduction and Literature Review

Mathematics is an essential subject, vital for people with or without special needs. Competency in mathematics enables us to count, manage time, perform wise financial transactions, engage in decision-making, and solve problems [1]. Despite the supremacy of mathematics, students at all levels, in Jamaica and even in developed countries, continue to display difficulties with mathematics thinking and processes [2, 3]. Students with mathematics difficulty (MD) frequently display low mathematics achievement; and may or may not have a mathematics disability, such as dyscalculia [4]. The low performance is attributed to “deficits in counting, computation, use of retrieval strategies, fraction comparison and estimation, and applied problem solving” [4] (p. 534). Students with initially low achievement in mathematics, especially during the elementary years, perform up to two standard deviations below average compared to high-achieving mathematics [5]. Undoubtedly, early detection along with targeted interventions can benefit these struggling mathematics students [4]. Nevertheless, Scammacca et al. [5] proposed that additional studies be conducted with the aim of closing the achievement gap between ordinary mathematics learners and those with MD.

Collectively, Jamaican students at the primary and secondary levels, despite the mathematics interventions, continue to perform below standard as evidenced by their dismal mathematics performance on primary and secondary school exit examinations such as, the Grade Six Achievement Test (GSAT) which was replaced by the Primary Exit Profile (PEP), and the Caribbean Secondary Education Certificate (CSEC). To put things into perspective, from 2015-2018, the national mathematics average in GSAT ranged from a low of 56% in 2015 to a high of 61% in 2018 [6]. In July 2021, the Honourable Fayval Williams, former Minister of Education, lamented the decline in PEP mathematics performance, noting that for the current sitting, the percentage of students deemed proficient and highly proficient on the PEP mathematics examination was 47.5% [7]. This means more than half of

the primary-aged children sitting the examination scored below average. Twelve months later, in the 2022 sitting of PEP, on aggregate, the percentage of primary school students categorized as proficient and highly proficient in mathematics (curriculum-based test) increased marginally to approximately 50.8%. This update indicated that approximately 50% of students hoping to enter the secondary school system, like in 2021, were rated as merely developing and beginning in mathematics [8]. The CSEC mathematics scores from 2018 to 2021 were similarly mediocre with the national cohort averaging approximately 57.8%, 54.6%, 61.2% and 38.2% respectively [9, 10].

The Ministry of Education, Skills, Youth, and Information (MOESYI) has initiated strategies to improve the mathematics teaching and learning landscape. Intervention strategies included the training and hiring of mathematics coaches and primary mathematics specialists, the training of mathematics specialists for early childhood education, along with hosting national mathematics expositions. In addition, the MOESYI, through the Mathematics Unit, since January 2023, has partnered with at least one teacher training institution in the parish of Kingston and St. Andrew, allowing some of the national mathematics coaches and specialists to assist in the direct supervision and mentoring of some primary mathematics student-teachers during their Year 3 and Year 4 practicum exercise. The efforts have transcended in the active process of informing the teacher training programmes to reflect the mathematics needs of the country using a data driven approach. The concerns of successive Ministers of Education were focused on how to arrest the poor mathematics outputs, and it is no different for the current Minister of Education, Skills, Youth and Information, Senator Dr. the Honourable Dana Morris Dixon.

Jamaica recognizes the diverse needs of its learners and has about 38 schools which cater to students with exceptionalities [11]. Most of these schools are monitored by the Special Education Unit in the Ministry of Education. Students with exceptionalities are educated in special education schools, special units, or in an inclusive classroom setting (a mixture of students with and without

exceptionalities in the general education classroom). However, the quality of mathematics instruction may be called into question in these inclusive classrooms when children with mixed abilities engage with teachers who are not always trained to teach them. The Deokoro Magnet Schools for the Gifted and Talented is one group of schools which has mastered the art of successfully differentiating the curriculum to educate gifted students who operate about two grade levels above their chronological peers, but in the 'normal' classroom setting would otherwise be 'held back', go unchallenged, and become disengaged [12]. Some secondary schools in Jamaica have embraced the recently restructured national curricula for Grades 7-9, now known as the Alternative Pathway to Secondary Education (APSE) I, II and III, to support struggling learners and those with exceptionalities. The APSE I mathematics curriculum was designed for the average Jamaican student who displayed proficiency in mathematics and needed minimal teacher intervention to excel in the subject. The APSE II and III mathematics curricula were designed to support students who are reading below grade level [13, 14], display signs of learning delays (Pathway II) and have special needs (Pathway III) [15]. The vision of the new standards curriculum was for schools receiving Pathways II and III students to be assigned a Pathway Coach(es), usually special education trained, to work alongside the classroom teacher to adapt the curriculum or instructional approaches and to systematically monitor students' progress [16].

There is little data on the frequency with which differentiated teaching is used in secondary mathematics classes in Jamaica. All student-teachers enrolled in teacher training institutions in Jamaica, regardless of their interest in Early Childhood, Primary, or Secondary education, are required to complete at least one short course in Special Education [16]. This is because it is recognized that some teachers may lack the necessary training for the successful implementation of DI. Even with this initiative, it did not seem like the semester-long special education course could teach students how to differentiate lessons for distinct mathematical concepts. This could mean that, annually, certain teacher preparation programs certify secondary-trained math teachers who have no practical experience tailoring their lessons to each student's unique requirements. The MOESYI and stakeholders have addressed Jamaican math student difficulties through policy, practical, and curriculum-based approaches. However, mathematics teachers in both special and general education classrooms need to gain a deeper understanding of their students' profiles and receive ongoing support, through training and access to resources necessary to successfully differentiate instruction. The Jamaican education system should also prioritize systematic implementation and monitoring of differentiated instructional approaches and students' mathematics learning outcomes.

The study examined teachers' perspectives of and experiences in using differentiated instructions to improve the mathematics performance of their students with exceptionalities and struggling mathematics learners at Grades 7- 8. A comprehensive analysis of current global and local research central to understanding the value of differentiated instructions and its impact on mathematics

learning outcomes of students was undertaken to set the foundation for the justification of this instructional approach to teaching mathematics to students with exceptionalities and struggling learners. The findings of the literature use key themes related to the four research questions, to include: (a) factors causing underperformance in mathematics among students with exceptionalities and struggling learners, (b) the extent to which teachers implement differentiated instruction, (c) teachers' perspectives on the effectiveness of differentiated instructions, and (d) areas that mathematics teachers need more support to meaningfully apply differentiated instructions.

### 1.1. Differentiated Instructions

Differentiated instruction (DI) is a research-based approach to teaching that caters to students' interests and preferences [17]. It involves four categories: content, method, product, and environment [18]. Math teachers in differentiated classrooms are free to adjust curriculum goals (math content), choose how students will acquire new concepts and skills (process), give students freedom to choose how they will demonstrate their learning (product) (e.g., through projects, individual assignments, group tasks, etc.), and/or decide how the classroom will be set up and the rules that will apply. Differentiated instruction in mathematics can include frequent assessments, guided discussions, direct instructions, problem solving with suitable scaffolds, mastery learning, projects, presentations, tiered learning tasks, explorations, the use of manipulatives and technology, flexible grouping to name a few.

### 1.2. Factors Contributing to Students' Under-performance in Mathematics

Some factors which inhibit the mathematics achievement of struggling learners and those with exceptionalities are subsequently discussed.

#### 1.2.1. Educational Policy

A country's educational policies have the power to positively impact quality teaching and learning of mathematics. Conversely, if the educational policies are not well conceptualized based on the population's needs it may impede the process of training and retaining quality mathematics teachers who are capable of adapting instructions for all types of learners. While Greece [19], Jamaica, and Kenya [20] struggled with low mathematics achievement among their secondary school students, Switzerland and Finland performed well in mathematics due to the implementation of educational policies which focus on student equity [19]. This implies that all students, regardless of their abilities, should receive the best education to reach their full potential. Realizing that "less than 20% of a given secondary cohort [exited] the formal education system with mathematics qualifications," Jamaica created the National Mathematics Policy in 2013 [21] (p. 4). The policy was also developed to address looming inequities that would see only a small fraction of the population accessing current and future opportunities [21].

#### 1.2.2. The Mathematics Curricula

The recent restructuring of the national curricula for Grades 7-9, with theoretical frameworks for supporting students on Pathways I, II and III, therefore, is a step in the right direction. The new National Standards Mathematics Curriculum (NSC), developed to address the current mathematics needs of the 21<sup>st</sup> century learners, boasts modified learning goals, suggested learning activities, and a variety of assessment strategies. The curricula support the use of Information and Communication Technology (ICT) and seem to promote the constructivist approach to teaching and learning. Some expectations of the Ministry of Education were that students, facilitated by creative, knowledgeable, and adaptable mathematics teachers, would be exposed to meaningful learning opportunities which in the very least: (a) challenged and inspired all learners according to their stage of readiness; (b) helped students to make sense of the world around them by connecting their past experiences with current knowledge about mathematical concepts and processes; and (c) encouraged students to think critically and helped them to develop greater perseverance [22]. The 2013 Jamaican National Mathematics Policy resulted in the development of a responsive curriculum, the new National Mathematics Curriculum (NSC) that is grounded in differentiated instructional practices and aims to improve the quality of teaching and learning in mathematics, similar to developed nations.

### 1.2.3. Students' Attitude Toward the Subject, Attendance, and Socio-Economic Status

The National Mathematics Policy document cited poor students' attitude toward the subject and the belief that mathematics has little relevance to students' daily lives as some reasons for their low performance [21]. Also, Karakolidis et al. [19] found that inconsistent school attendance in the early years, and low socio-economic status of both the students and their schools, significantly predict low achievement in students. This viewpoint appears to be in line with the opinion held by some Jamaicans that some secondary schools—those in "troubled" neighbourhoods, where there are large class sizes and frequent absenteeism—are likely to fail without strong leadership and adequate resources.

### 1.2.4. Inadequate Tools for Instruction and Inappropriate Teaching

The 2017 National Education Inspectorate (NEI) report for Jamaica recommended that attention be given to the proper use of pedagogy and tools during instruction, after a statistical assessment among primary and secondary school students discovered that in 31% of the inspected institutions "teaching in support of students' learning was unsatisfactory" [23] (p. 52). According to Dwyer [23], these findings implied that some students' poor performance was linked to weaknesses in their teachers' "knowledge of the subjects and how best to teach them; poor planning of learning activities; ineffective teaching strategies; and ineffective assessment practices" (p. 52). These instructors' inadequate ability to differentiate instruction in the schools inspected by the NEI is implied by their inability to create meaningful teaching methods and implement efficient assessment procedures. Lai et al. [24] pointed out that fostering an equitable and differentiated mathematics learning environment requires the use of numerous teaching

modalities in conjunction with effective formative assessment tools to monitor students' development. Similarly, Smale-Jacobse et al. [25] found that teachers often struggle to adapt their lessons to meet the needs of their students, resulting in the needs of high achievers being left unaddressed and struggling learners being assigned challenging tasks (far beyond their zone of proximal development) [26]. While the 2017 NEI report and those of Smale-Jacobse et al. [25] did not directly address mathematics teaching and learning, the results point to a widespread issue that permeates our mathematics classrooms, negatively impacting students' overall mathematics performance.

## 1.3. The Extent of Mathematics Teachers' Use of Differentiated Instruction

The extent to which Jamaican math teachers use tailored instruction (DI) to meet the needs of struggling children in Grades 7-8 as well as those with exceptionalities is unknown. Nonetheless, studies revealing Jamaican pupils' subpar mathematics proficiency can offer insightful information into the possible extent of its use and effectiveness. The most frequently used differentiated strategies and the factors that hinder their use are subsequently explored.

### 1.3.1. Frequently Used Differentiated Instructional Strategies

Onyishi's and Sefotho's [27] study among a sample of 382 primary school teachers from Enugu state, Nigeria, trained in differentiated instructions (DI), uncovered that thirty-three percent of the sample used the multisensory approach allowing students to use their senses to learn; while 21% used tiered instructions to provide multiple avenues for learning (e.g.: compacting the curriculum, using learning centres). The DI strategies least employed by these teachers were: (i) compacting the curriculum for the gifted, while providing developmentally appropriate challenging tasks for the middle tier and those with learning difficulties (11.2%); (ii) individualized teaching (3.9%); (iii) allowing students options to demonstrate their learning using choice boards (2.6%); and (iv) facilitating cooperative learning (1.3%).

A comparative study examining the use of differentiated instructions among public and private primary schools found that these teachers frequently differentiate instruction by product, that is, allowing students' diversity in displaying their understanding [17]. This finding could suggest that the teachers need more help in content and process differentiation. Pozas et al.'s 2019 study on German secondary school teachers' use of differentiated instructional practices in mathematics lessons found that DI practices were used infrequently. However, when used, tiered instruction and heterogeneous ability groups were common. Peer-tutoring and project-based learning were the least frequently used differentiated instructional approaches. Teachers likely tend to implement differentiated instructional practices which take less time to prepare especially when faced with demanding workloads due [28].

### 1.3.2. Factors Which Impact the Use of Differentiated

### Instructions

Mathematics teachers' perspectives on the use of differentiated instructions to improve their students' mathematics outcome vary based on the teachers' level of training and confidence, access to ongoing professional development, the needs and responses of the student population, classroom size and layout, the availability of modern teaching aids, and the support from the school administrations, parents, and the Education Ministry [27]. While limited data exists on how frequently differentiated instructions is applied in the Jamaican secondary mathematics classrooms, barriers such as teachers' self-efficacy (how confident they are in their ability), teachers' philosophy, teacher training, teaching experience, professional development, and class size are known to impede the positive implementation of differentiated instructions [29]. The implementation of differentiated instructions is increasingly impractical as class size exceeds 20 students [30]. Despite the Government of Jamaica's plans to reduce the teacher-student ratio to 1:25 [31], to date, in some Jamaican schools, the average class size is about 1:48 [32]. Differentiated instructions is time consuming [27, 33]; requires intense effort for teachers' mastery [33]; and teachers find it difficult to implement in a mixed ability classroom [27]. Besides inadequate planning time, the increasing number of teacher obligations (teaching, administrative etc.), and rigid timetabling which does not facilitate teacher-to-teacher collaboration make the wide scale and sustained implementation of differentiated instructions even more frightening for classroom teachers [33]. Some teachers also believed that implementing differentiated instructions may negatively affect their ability to complete curriculum content in the allowed time [27]. These revelations show difficult challenges many teachers, including those in Jamaica, face in creating an inclusive educational space for their children.

### 1.4. Effectiveness of Differentiated Instructions to Improve Mathematics Performance

Differentiated instruction, when fully implemented, is known to positively impact students' learning outcomes [34]. A quasi-experimental study conducted by Muthomi and Mbugua [20] corroborated this finding by proving that 89% of Form Three mathematics students in Meru County, Kenya, saw an improvement in their mathematical achievement after differentiated instructional practices were applied. The remaining 11% experienced no change in their mathematics performance. Therefore, from that study, differentiated instructions did not have a negative impact on mathematics achievement. Experimental research conducted by Bal [35] among Grade 6 students who were learning Algebraic concepts, in Saricam County in Adana, Turkey, positively affirmed that the students who were taught using the tiered teaching differentiated approach scored higher on post-tests than those taught using conventional strategies. Not only did these students reap academic success (that is, higher mathematics scores), they also reportedly had a new appreciation for mathematics (affective benefits).

Differentiated strategies such as curriculum adaptation and intentional flexible grouping can considerably improve mathematics achievement [36]. Faber et al. [37] explored

through the observations of 144 Grades 2-5 mathematics teachers the relationship between differentiated instruction and the learning outcomes of students in a data-based decision-making learning environment. The findings of the research disclosed that students from different ability groupings did not equally benefit when taught mathematics using differentiated instructions. This means, ability grouping as a differentiated approach in the mathematics classroom proved most beneficial to average-ability students. It had a negative effect on low-ability students while there was no impact on high-ability students.

While research champions the benefits of differentiated instruction there is a need for further scientific research for secondary school students "regarding the effectiveness and value of different approaches to differentiated instruction" [25] (p. 1). To improve their effectiveness, mathematics teachers need greater insight into which specific approach(es) to differentiation is/are most helpful for students with named characteristics.

### 1.5. Appropriate Resources, Information and Training

Reasons vary for the complete avoidance of, misuse, or inconsistent use of differentiated instructions by mathematics teachers who educate struggling learners and those with exceptionalities. A study conducted by Onyishi and Sefotho [27] among primary level Nigerian teachers trained in the use of differentiated instruction revealed that, notwithstanding their training, there were areas in which they needed additional support in order to effectively cater to their mixed ability students through differentiating instruction. More than half of the sample of teachers in that study disclosed that they needed more information in the ensuing four areas:

- a) Developing rubrics for assessments (51% of the teachers).
- b) Designing meaningful student-centered assessments (53% of the sample).
- c) Creating and implementing project-based learning experiences for the students (62%).
- d) Successfully implementing differentiated instructions while managing a large class (80% of the sample).

Fifteen percent of the sample would benefit from guidance on how to apply differentiated instruction without compromising on curriculum content while 18% wished to learn more about how to design student activities and ask questions which promoted students' thinking across the levels of the Blooms taxonomy. In the same study 80-99% of the teachers also expressed a need for: (a) timely and ongoing training in the use of differentiated instructions, and (b) a monitoring team to be set up to keep track of teachers' use of differentiated instructions [27]. Brighton et al. [33] believed that teachers need tangible (e.g.: modern and adequate teaching aids) and psychological assistance to remain motivated to successfully implement differentiated instruction in their classrooms. Additionally, professional development and coaching sessions should focus on helping teachers to make use of available resources and organizational structures which already exist to minimize teachers' becoming overwhelmed by the complexities of

differentiating instructions in the first stages of its implementation [33].

The results of statistical research conducted by Goddard et al. [38] implied that school administrations are “vital to the instructional climate of schools” (p. 353). Findings of that study also implied that teachers from schools which had supportive administrators were more likely to report that the use of differentiated instructions was prominent in their schools. Therefore, beyond the weight of responsibility mathematics teachers carry in effecting differentiated instructions, it would be remiss to downplay the critical role the school’s administration can play in driving an effective school-wide differentiated instructional approach.

### 1.6. Rationale for the Study

This study aims to investigate the effectiveness of differentiated instruction in addressing the needs of struggling mathematics learners and students with exceptionalities at the lower secondary level in Jamaican schools.

### 1.7. Significance of Study

This study provides valuable insights into the role of differentiated instruction in improving mathematics outcomes for diverse learners, informing educational policies and teacher training programs in Jamaica.

### 1.8. Research Questions

This study was guided by the following four research questions.

- 1) What are some of the factors which cause students with exceptionalities and struggling learners to underperform in mathematics?
- 2) To what extent are mathematics teachers using differentiated instructions to support the mathematics learning needs of their students with exceptionalities and struggling learners?
- 3) What are the mathematics teachers’ perspectives on the effectiveness of using differentiated instructions to improve the mathematics performance of students with exceptionalities and struggling learners?
- 4) What types of training or information do teachers of mathematics need to successfully apply differentiated instruction?

### 1.9. Definition of Key Terms

- *Differentiated Instruction* - This is a responsive, individualized, and well-researched approach to teaching which is used to increase the learning outcomes of students [39]. It is an effective approach as the differentiated classroom offers students multiple ways to engage in learning by acquiring material (content), making sense of the information (processing), and demonstrating their learning (product) [18]. Teachers also differentiate instructions when they work to establish an orderly, friendly, and inclusive learning environment for their pupils [24].

- *Exceptionalities* - This term refers to both giftedness and the 14 categories of disabilities [40]. The broad term is commonly used to minimize the stigma associated with the term disabilities. A child must be formally assessed according to national/international standards to be diagnosed as having an exceptionality [41]; consequently, they may or may not need special education.
- *Mathematics Performance /Achievement* - “Mathematical Achievement is the competency shown by the student in the subject mathematics. Its measure is the score on an achievement test in mathematics” [42] (p. 1951).
- *Struggling Learner* - The term, adapted from Louie et al. [43], described students who performed poorly on mathematics assessments or who are believed to need additional mathematics support by the teacher.
- *Underperformance* - Academic underperformance is a term used to describe a student who is working below his/her potential or ability; thereby, not achieving what he/she should [44].

## 2. Methodology

### 2.1 Study Design

#### 2.1.1. Phenomenological Qualitative Research Design

A phenomenological qualitative research design was used to gain greater insight into the mathematics teachers’ perspectives of and experiences in using differentiated instructions to improve the mathematics performance of students with exceptionalities and struggling learners at Grades 7-8 in seven schools across the counties of Surrey and Cornwall in Jamaica. The main objective of a phenomenological study, sometimes called phenomenological inquiry, is to obtain a deep understanding of a phenomenon through the lived experiences and feelings of participants [45]. The phenomenon for this study is the use of differentiated instructions by Grades 7 and 8 mathematics teachers to support their struggling mathematics students or those diagnosed with exceptionalities. From these teachers’ authentic, common or diverse experiences, practices and policies can be implemented to further support them and other mathematics teachers who would have had similar experiences. In doing so, mathematics students at the lower secondary level who are struggling with mathematics or have special needs will receive more structured and meaningful support to improve their mathematical learning outcomes.

#### 2.1.2. Qualitative Research

Using techniques like observations and interviews, often with a small sample, qualitative research "is an unstructured, exploratory method" of study used to get in-depth information of human behaviour, their thoughts, and experiences [46] (p. 2829). Therefore, the qualitative design was most suitable to obtain specific and detailed perspectives of the mathematics teachers which would otherwise not be captured using a simple questionnaire (quantitative design/tool). Further, recommendations from the detailed information received can help other schools understand what their mathematics teachers may be enduring. This presumably is a good precursor to worthwhile conversations about their own experiences with

using the differentiated approach for supporting their mathematics students. Some academics argue that qualitative research has a credibility gap compared to quantitative due to its non-statistical conclusions, despite its suitability for this study [47]. Rahman [47] also cautioned that because of their non-statistical nature and small sample size, qualitative research findings cannot be used to draw broad conclusions about the population.

## 2.2. Sampling Technique and Sample Size

Purposive sampling was used to select the eight (n=8) participants (one male and seven females). The teachers were from 7 research sites – 3 special education schools, 3 traditional public high schools, and a private school, located in the counties of Surrey and Cornwall, in Jamaica. They were assigned to Grades 7 and/or 8 students who had been diagnosed with an exceptionality and/or classified as struggling mathematics students. The researcher chose the targeted high schools and special education schools because of their proximity, her professional connections with participating teachers, and her rapport with other mathematics teachers employed at the target schools. Additionally, the researcher was familiar with the characteristics of the student population at these secondary and special education schools, who were either diagnosed with an exceptionality or struggling with mathematics. Furthermore, the researcher thought that because of their personal experiences teaching struggling mathematics learners or those with exceptionalities, the math participants' involvement would help provide answers to the research questions. Moreover, it was essential that each participant involved received professional training in teaching students with special needs, had at least taken a foundational course in the subject or had years of experience educating students with special needs. Teachers with professional training in teaching special needs were likely familiar with differentiated instruction. Their insights on its application, impact on students' outcomes, and challenges helped identify areas for effective implementation of DI to support exceptional and struggling math learners.

Creswell [48] proposed that the sample size for a phenomenological study be small; ranging from three to 15 participants who have all experienced the phenomenon. Therefore, for this study, the sample size of eight would be sufficient. A sample size greater than eight might not have yielded any new information. Guest et al. [49] in their study which examined a useful method for reporting saturation in qualitative research recommended a low of six to a high of 12 participants to achieve desirable themes and information. Guest et al. [49] described the saturation level as the point at which new information received during interviews could yield diminishing returns. That is, the new information would add little value or no new unique information based on the purpose of the research. The teacher-researcher used this basic definition to determine that having more than eight participants for this phenomenological qualitative study would not significantly yield any new information and may make data analysis even more tedious. Furthermore, Hennink and Kaiser [50] endorsed the fact that a small sample size for qualitative research is effective. Their inquiry about suitable sample sizes for qualitative research

concluded that for homogenous populations saturation levels were attained with a sample size of “(9–17) interviews or (4–8) focus group” sessions (p. 9). The sample composition is outlined in Table 1.

**Table 1:** A brief description of the research sample

Research Site	Teacher Code	Gender	Qualification	Role, Grade and Approximate Class Size
Site 1	Teacher 1	Male	1 <sup>st</sup> degree in Secondary Mathematics	Assigned one Grade 8 with an approximate class size of 30 students.
Site 2	Teacher 2	Female	1 <sup>st</sup> degree in Secondary Mathematics	Assigned mostly Pathway II students at Grades 7 and 8. Students in regular attendance ranged from 12 to 28 students.
Site 3	Teacher 3	Female	1 <sup>st</sup> degree Double major in Mathematics. Master of Education in Special Education (pending)	Mathematics specialist assigned mostly to Grades 7 and 8. Most students are on Pathway III with one class being Pathway II. On average there are 32 (Grade 7) and 25 (Grade 8) students respectively.
Site 4	Teacher 4	Female	1 <sup>st</sup> degree in Psychology	Teacher 4 is a special educator who supports Teacher 5.
	Teacher 5	Female	1 <sup>st</sup> degree in Secondary Mathematics	Teacher 5 is assigned seven students with special education needs at Grade 7 and an inclusive Grade 8 class of approximately 15 pupils.
Site 5	Teacher 6	Female	Dip. in Special Education specializing in Hearing Impairment	A special educator who teaches functional mathematics to five Grade 7 students.
Site 6	Teacher 7	Female	1 <sup>st</sup> degree in Managing Learning Difficulties	The Grade 7 mathematics class comprises approximately 10 pupils.
Site 7	Teacher 8	Female	1 <sup>st</sup> degree in Special Education specializing in Deaf Education (pending)	Teaches mathematics to two Grade 7 students with exceptionalities.

## 2.3 Instruments and Data Analysis

Semi-structured interviews were conducted online and via telephone between May and June 2022. An interview schedule consisting of closed-ended questions and approximately 18 open-ended questions was used. The interview schedule provided background information on participants and students, including school type, class size, math teacher qualifications, and students diagnosed with exceptionalities or those deemed as struggling mathematics learners. The structure of the schedule also allowed for more pointed discussions that were correspondingly in line with the themes from the four research questions related to students' underperformance in mathematics, the use of differentiated instructions (DI), perspective on DI effectiveness, and additional information and training. A research supervisor was asked to review the interview questions in order to validate them before interviews commenced. The advice of a tertiary mathematics lecturer who also served as the Staff Research Coordinator for the Department of Mathematics at a teacher training institution was also sought regarding the structure of the interview schedule. During the vetting process, the Research Coordinator flagged questions that were excessively wordy and assisted the researcher in organizing the items into the relevant research question areas. Additionally, prior to the start of the official interviews, a pilot interview was conducted with a Grade 8 mathematics teacher. The response received on the question "describe how DI was used to support the weaker students or those with exceptionalities" during the pilot interview with the Grade 8 mathematics teacher was adequate to obtain detailed information on item number 3 under Research Question 3. Therefore, item number 3 for Research Question 3, which asked the participants to "describe some experiences (positive, negative, or both) you have had with using differentiated instructions," did not need to be covered by the researcher in subsequent interviews, depending on the depth of responses from the participants. Seeking expert advice and piloting the interview questions allowed time for restructuring or exclusion of questions which were redundant or ambiguous.

Document analysis which involved the review of one lesson plan from some of the participants was also done to corroborate the data regarding the types of differentiated approaches the teachers used and its extent, thereby answering research questions 2 and 3. For instance, Teacher #5's use of choice and technology—websites, games, and videos—to support her students' learning preferences and offer individualized instruction was validated by the sample lesson plan that was received from Research Site 4.

The transcriptions from the interviews obtained using Otter.ai were coded and further analyzed according to common themes and responses. Direct quotes from participants that precisely expressed their ideas and experiences were used thanks to transcriptions from the recorded interview sessions. Although it was utilized sparingly, peer debriefing was used in conjunction with the support of another math lecturer who doubles as the Student Research Coordinator (SRC) for the mathematics department at the researcher's college. The procedure of letting a qualified, unbiased colleague or small number of colleagues evaluate some parts of the thesis is known as peer debriefing [51, 52]. Peer debriefing was cautiously undertaken by sharing only a few of the voice recordings of interviews and related transcriptions with the SRC for her to cross check them. She also assisted with the coding for Chapter 4. The goal of the peer debriefing was to strengthen the study's credibility since this impartial party was able to identify mistakes in the work, weaknesses in the researcher's reasoning and analysis, and/or over- or under-emphasis on certain points of view for Chapter 4.

## 2.4 Ethical Considerations

Ethical considerations for this study included gaining permission from the principals, informed consent of participants, correct reporting of findings, the use of the APA 7<sup>th</sup> Edition format for referencing sources, and the protection and ethical sharing of data.

### 2.4.1. Gaining Access

Telephone and electronic (email) contact was made with the principals of the schools to gain initial access. Similar modes of communication were used to contact the participants once permission was granted. Letters of permission were subsequently issued to the principals and the prospective mathematics teachers. Prior to the commencement of the interviews each participant was given the option to withdraw at any time they deemed fit or decline from answering specific questions.

### 2.4.2. Data Collection and Storage

The interview instrument was coded to maintain the privacy of the participants, while still allowing the researcher to correctly match data for triangulation and analysis. The names of the schools, their specific locations or other identifying details were removed from the body of the research. Sensitive information concerning the mathematics teachers' perceptions and pedagogical skills, which if left carelessly could cause embarrassment, was secured.

### 2.4.3. Reporting

The researcher meticulously reviewed each transcription and

corrected any software-made errors to accurately reflect the participants' thoughts and responses. The researcher exercised due diligence during data analysis and cross-referencing with secondary sources to ensure the accuracy of the respondents' opinions. The facts were presented in a manner that did not cause any embarrassment to the participants. The participating schools were informed that the findings would be shared with the researcher's supervisor. The study adhered to APA 7th Edition criteria for ethical and correct source acknowledgment, with a section dedicated to references and in-text citations throughout

## 3. Results and Discussion

Findings and in-depth analyses of the Grades 7 and 8 mathematics teachers' experiences in using differentiated instructions to improve the mathematics performance of their students with exceptionalities and those deemed as struggling learners, according to the four research questions, are presented using narratives and figures.

### 3.1 Teacher Participants

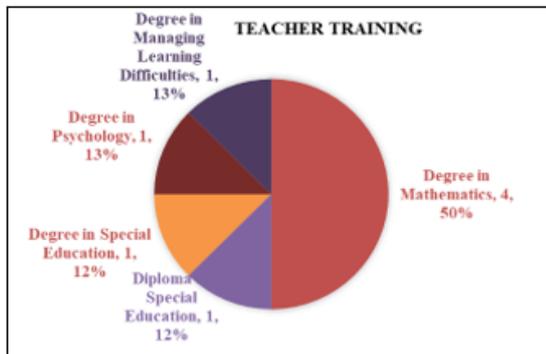
Of the eight teachers interviewed, four had graduated from Teachers' College within the last three years, one was expected to graduate from college at the end of the academic year, and the remaining three teachers had between eight and 22 years of experience serving students with special education needs or otherwise. Interestingly, the teachers who had eight or more years of service were all special education trained. Seven of the eight teachers, as seen in Table 1, were hired to teach mathematics while one served as a Special Educator (Teacher 4) supporting mathematics Teacher 5.

### 3.2 Results and Discussion Based on Research Question 1

*What are some of the factors which cause students with exceptionalities and other struggling learners to underperform in mathematics?*

#### 3.2.1. Teacher Training

Only 50% of the sample, as seen in Figure 1, had at least a first degree in teaching secondary mathematics, with three teachers (Teachers 4, 6 and 8) having had extensive, formal training (at least a Diploma) in special education. Teachers 1, 2 and 5's, holders of first degrees in mathematics education, exposure to special education occurred in their final semester of Teachers' College when they did the compulsory course, "Teaching Students with Special Needs in General Education Classrooms". Teacher 3 has a first degree in teaching secondary school mathematics and, at the time, was pursuing special education at the master's level.



**Figure 1:** Chart showing the type of training for the eight interviewees

Therefore, in the research sample, some had only extensive formal training in mathematics content and pedagogy but not special education, whereas the others only had formal training in special education but not mathematics content and pedagogy. Binns-Thompson et al. [2], in their research which explored the level of impact the competence of both the special and general educators can have on their students' mathematics achievement in an inclusive setting, found out that mathematics educators who had an accompanying special education degree demonstrated better mathematical skills and competencies when compared with those without a degree in special education. Given her years of experience teaching mathematics, the researcher naturally agreed with the viewpoints expressed by Binns-Thompson et al. [2] before the start of this research study. Having earned a master's degree in special education, the researcher believed that through interactions with her trainee mathematics teachers, the additional skill set might be helpful in directly providing more targeted, tailored mathematics lessons to struggling learners or those with exceptionalities. Even though the same study did not prove that such mathematical knowledge was instrumental in improving their students' mathematics achievement; it emphasized that the regular presence of a special education teacher and their unique skill sets were vital to improving the mathematical gains of students in the inclusive classroom [2]. Yoong and Fu Sai Hoe [53] conducted a statistical investigation to ascertain the efficacy of Malaysian math teachers in instructing primary-aged students with math learning problems. Despite what some may believe, the data demonstrated that there was no statistically significant connection between the years of experience and the efficacy of teachers. However, as compared to those with certificate training, this study showed that math educators with higher qualifications—such as a master's or PhD—had a more positive opinion of their own competence in supporting children who struggled with math. Therefore, rather than years of experience, the quality of a mathematics teacher's formal training determines how well they believe they can implement differentiated teaching. Nonetheless, more statistical analysis would have to be done on the sample and respective target schools to ascertain the statistical significance and correlation among formal teacher training, teacher experience in mathematics and special education, the effectiveness of teaching and assessment strategies, and students' performance.

### 3.2.2. Students' Attitudes, Skill Gaps, and Learning Challenges

When asked their opinions on students' underperformance, the most frequent reasons the educators attributed to their Grade 7 or 8 students' poor performance in mathematics were: (a) the students' negative attitudes and beliefs, (b) content or skill gaps, and (c) math learning difficulties.

#### 3.2.2. (a) Students' Attitudes

Students' attitudes and perception of mathematics such as them being demotivated, mathematics being boring, and their reluctance to try, ask for help, or accept help were highlighted by the teachers. This seems consistent with the report from the National Mathematics Policy document where it reported that students' negative attitude towards mathematics and its abstract nature were hindrances to their own success in the subject [21]. Teacher 5 shared thoughts on how some students' attitude impeded their progress in the following quote:

They do not want you to pull them out to offer that special help that they need. ... Even when you read their IEPs and you're like, this student needs to go to a separate room they say, "miss, why?", and they don't want to go so those things change their emotional state and how they would perform normally.

Teacher 3, in sharing an experience, implied that some students who received 'special help' were stigmatized; that is, were called 'dunce' by their peers. As a result, it is possible that this is another reason that the struggling mathematics students refused help.

#### 3.2.2. (b) Skill Gaps and Learning Challenges

The skill and content gaps mentioned by the teachers were either an ongoing problem from previous years due to learning challenges (for example, Teachers 2 and 3), a result of students' special needs (for example, Teachers 4 - 8), a result of online teaching because of the onset of COVID-19 (in the case of Teachers 1 and 4), or the day-to-day learning gaps which emerged and could be remedied by one-on-one student assistance (consultation sessions). The mathematics learning difficulties which the teachers put forward as barriers to students' mathematics progress included students' poor reasoning and problem-solving skills, poor memory recall, processing problems and their mathematics comprehension challenges. The mixed methods research conducted by Varaidzai Makondo and Makondo [54] substantiated the teachers' experiences in that students' poor memory, their inability to make connections in mathematics and build on their previous learning, and their inadequate mathematics foundation (learning gaps), were predictors of their underperformance.

#### 3.2.3. Inadequate Sign Language Symbols

One barrier which was unique to Teacher 8 and her students was the lack of what she called 'complex' signs (sign language) for the more advanced mathematics concepts and operations. This she said made the teaching and learning of mathematics a challenge as both herself and her students had to create their own signs to express secondary school mathematics ideas and thinking.

### 3.3 Results and Discussion Based on Research Question 2

*To what extent are mathematics teachers using differentiated instructions to support the mathematics learning needs of their struggling mathematics students and those with exceptionalities?*

#### 3.3.1. Frequently Used Differentiated Instructional Strategies

A variety of differentiated instructional practices were employed by the participants to support their Grade 7/8 struggling mathematics learners including those with exceptionalities. Some of the most frequent practices mentioned were one-on-one assistance, tiered learning activities, respectful student tasks, scaffolding, ongoing assessment, and multi-modal learning activities. Others of interest included sign language, flexible grouping, guided questions with choice, and behaviour management techniques such as 'planned ignoring' to boost students' confidence. Planned ignoring in special education or classroom management involves deliberately ignoring some challenging or undesirable behaviours of students [55] so as to minimize or eliminate its occurrence. It must be emphasized that this approach is not recommended for use with students who cause injury to others or themselves [55].

Teacher 4 described how behaviour management strategies such as 'ignore', and positive feedback were used to reassure a 'high flying' student who sometimes struggled with math anxiety.

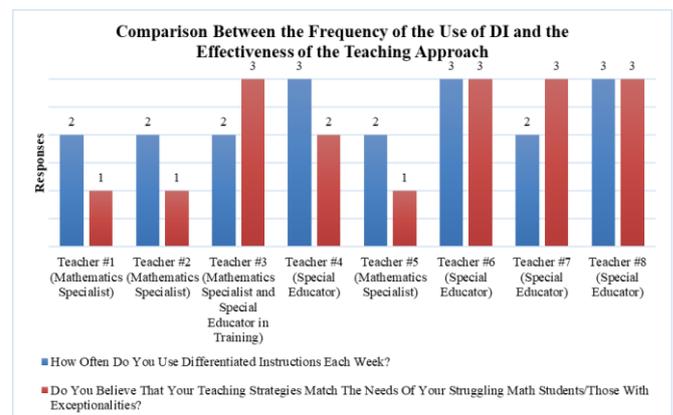
When doing computations, the student would frequently ask for confirmation for every question, for example, "... three times four is 12, right, miss?" So, we would just stop answering her and would be like, ... look, you know what you're doing. You need to trust that what you're doing is correct."

Teacher 8 explained how guided questioning with choice was used to support her learner with autism spectrum disorder (ASD) when teaching about conversion of metric units. For example, she would ask the student, "What do you do when you are dividing?" or "What do you do when you are changing a smaller unit to a larger unit, do you divide, or do you multiply?" She said she cannot just ask the question, "how do you convert from a smaller unit to a larger unit?" She must give the student a choice, or he may not be able to properly express himself. Sabaruddin et al. [56] in their case study which explored how a student with ASD learned mathematics, shared how integral the posing of questions was, and providing answer choices were to the mathematical progress of the student with ASD. Though the participants used a variety of teaching styles, only two were included in this discussion.

#### 3.3.2. Frequency of the use of Differentiated Instructions

The teachers were asked to rate the frequency with which they employed differentiated approaches in their weekly lessons. Their responses were coded as follows: 1- Used in a few lessons, 2- Used in most lessons and 3- Used in every lesson. They were also asked to indicate how well they believed that their mathematics pedagogy aligned with the

needs of their students. Their responses were also coded as follows: 1- Yes, sometimes, 2- Yes, most times and 3- Affirmatively (consistently), yes and are viewable in Figure 2.



**Figure 2:** Comparison between the frequency of the use of DI and the effectiveness of the teaching approach

Fascinatingly, the information presented suggests that most of the mathematics specialists (Teachers 1, 2 and 5) felt that, despite their efforts, their teaching strategies only met the needs of their Grade 7 and 8 struggling learners or those with exceptionalities occasionally. Incidentally, these teachers had only recently completed their first degree within the last 3 years. The special educators, Teachers 3, 6, 7, and 8, were more confident that their best efforts suited their students' needs and hence their teaching methods were not necessarily the cause of their students' underperformance. The regularity with which the special educators used differentiated instruction in their weekly lessons was consistent with their favourable evaluations of their method of teaching mathematics, indicating that it meets the requirements of the children. Their responses portrayed them as being more confident and consistent in their application of differentiated approaches when compared to the mathematics specialists (Teachers 1, 2, 5). Sankardas [57] noted a similar pattern in the Indian teacher sample, wherein the special educators who demonstrated higher self-efficacy in the use of DI were more confident than the general education-trained (mainstream) teachers in their ability to meaningfully differentiate lessons for their differently abled students, especially those with autism. The mainstream teachers, like some of the study's participants, advocated for additional training to diversify instruction, adapt curricula, and provide academic accommodations for their exceptional students.

Teacher 8 provided a measured explanation for the frequency with which she differentiates mathematics instructions for her students. She said that she differentiated in every mathematics lesson if her students had a challenge. For example, she clarified, if she knows that her student cannot manage to write then he (student with ASD) will get something to match. She said she used differentiation (scaffolding etc.) until the student has mastered the task and can move to the next level on his/their own.

#### 3.3.3. Factors Which Impact the use of Differentiated Instructions

The research participants firmly believed in differentiated

teaching for improving the achievements of Grade 7/8 struggling students and those with exceptionalities but expressed apprehension about its effective implementation. Some of the barriers to the effective implementation of differentiated mathematics instructions from the eyes of the teachers were: time (limited/time-consuming), teacher's experience, insufficient support, inadequate supply of teaching aids and technologies, lack of understanding of students' needs, large class sizes, inflexible timetable, and the expansive curriculum. Four of these prohibitive factors, commonly expressed among the participants, are further discussed.

### 3.3.3. (a) Large Class Sizes

Teachers 2, 3, and 5 expressed concern about the size of their classes. To put things into perspective, Teacher 3 was the sole teacher assigned to a Grade 7 Pathway III class which comprised approximately 32 students and a Grade 8 Pathway II class which contained 25 students. Recall that students in Pathways II and III could encounter challenges such as learning delays and disabilities and would require special education. Therefore, due to the large student numbers the effectiveness of her application of differentiated instructions will be increasingly impractical as implied by [30]. Alternately, Teacher 5 had a Grade 7 special educational needs (SEN) class with 7 students and still found it difficult in a single class to provide for all their needs. While Teacher 4 was assigned a special educator teacher and Teacher 3 had access to an Alternative Pathways to Secondary Education (APSE) coach, these support staff were also required to attend to the entire school which negatively affected the frequency of their class visits. Hollowell [30], however, recommended that when class sizes are large teachers will have to skillfully employ flexible, small learning group strategies to better manage their learners. Despite their best efforts, a few of the participating teachers were still unable to implement meaningful differentiated instruction, such as scaffolding their students' learning, due to the large class size resulting in large groups or large numbers of small groups, student needs within groups, and limited teaching time per lesson. Given the dynamics of their classrooms, the researcher found it easy to empathize with the participants in the interviews who wanted to employ meaningful differentiated mathematics strategies that others had claimed to be beneficial, but believed they were hindered by several limits. Oloo and Nyongesa [58] noted a similar challenge with effectively employing differentiated mathematics instructions among students in Kenya with math learning difficulties when classes were large. On a positive note, as with Tieso [36], they were of the view that the deliberate application of flexible (mixed ability) grouping could considerably improve mathematics achievement. Although ability grouping can reinforce some status-reinforcing ideologies that are deeply ingrained in the country's culture, and have negative social and academic effects, some Kenyan mathematics educators have demonstrated success in using the grouping approach to teach students who have difficulty with the subject [58].

### 3.3.3. (b) The Curriculum

Teachers at Research Sites 4 and 7 affirmed that their administrations were cognizant of the needs of their students

and as such did not pressure them to complete an expansive curriculum. They were given the leverage to modify the learning goals and assessments to align with the needs of their students. According to Sabaruddin et al. [56] some mathematics curricula are expansive and unsuitable for some students with special needs. Moreover, the attention span of students with special needs tends to be lower than their non-disabled counterparts [56]. Therefore, Sabaruddin et al. [56] proposed that educators be given flexible opportunities to make mathematics learning fun and practical for their students with special needs to capture their attention and keep them motivated. They also need to be equipped with the requisite skills to sequence the mathematics tasks in a way that their students can reasonably process the mathematics [56].

### 3.3.3. (c) Time Consuming and Labour Intensive

Teachers 3, 6, and 8 expressed how demanding differentiating instructions can be. Teacher 3 said that "The problem is that differentiating instructions takes a lot of time. Effective implementation requires extensive planning." Teacher 6 stated "...It is definitely more work. Sometimes I ... set 3 different worksheets. Other times I have to vary the number of questions on the worksheet for some students because I want them to be able to accomplish the task." And Teacher 8 stated that "Differentiating a lesson takes more time. But [you have to] give them a lot of practice. Find different activities to allow them enough practice and vary the approach."

### 3.3.3. (d) Insufficient Support

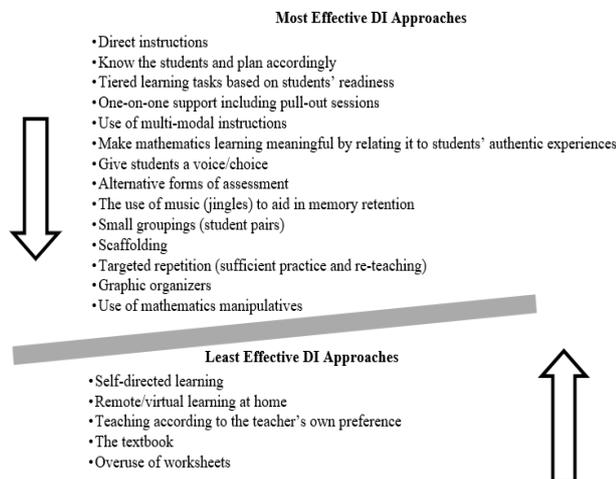
Teacher 4 (special educator) knew this experience all too well. She explained how challenging it was at times working alongside some general education trained mathematics teachers. To handle varied staff attitudes, she employed emotional intelligence by suggesting and reminding; but ultimately, the final decision resided with the general mathematics educator. Teacher 4 believed that directives from the school's leadership could help to mitigate this barrier. Further, she even asked during our conversation if teachers receive basic training in differentiating instructions as it appeared this was lacking among some of the general educators she had encountered.

## 3.4 Results and Discussion Based on Research Question 3

### *What are the mathematics teachers' perspectives on the effectiveness of using differentiated instructions to improve the mathematics performance of students with exceptionalities and other struggling learners?*

Whilst the sample of teachers positively acknowledged differentiated instruction as the best approach to improving the mathematics performance of their students, Teacher 3, like Van Geel et al. [59], believed that there was more to differentiating instructions than what meets the eye. That is, differentiating instructions is a complex process [59]. Teacher 3 explained that some mathematics teachers, including herself, do differentiate instructions, however, at times they may be differentiating the wrong component. She said, at times, she might have differentiated the mathematics content when based on the students' need at the time much

more would have been achieved had she differentiated the environment and/or the process (how students will acquire the new material). So, while the theoretical benefits of differentiating instructions are undeniable, Grade 7 and 8 mathematics educators must be knowledgeable about the most effective approach(es) for the need at hand. The participants confirmed that there were some differentiated strategies which their mathematics learners responded better to than others, as seen in Figure 3.



**Figure 3:** Teachers' view of the most and least effective DI strategies for improving students' mathematics performance

### 3.4.1. Most Effective Differentiation Strategies

#### 3.4.1. (a) Student Profile

Teachers 3, 4 and 8 (the special educators) insisted that educators must have a good understanding of the profile of their students to meaningfully differentiate mathematics instructions for the Grade 7 and/or 8 students they served. Student profiles may include, but are not limited to, the students' exceptionalities, if any, and how this may impact them, their strengths and weaknesses, levels of readiness and their learning preferences. It was Gardner's belief, according to Cannon [60] that an instructor's knowledge of their students' intellectual capacities and how they learn made them more capable of meeting the distinct learning needs of their students.

#### 3.4.1.(b) Incorporate Students' Voice and Choice

The use of conversation, as seen in Figure 3, was one differentiated teaching strategy which was useful in improving the output of their mathematics learners (those with exceptionalities or deemed struggling). Teachers 1, 3, 4 and 5 shared how they openly engaged their students in conversation to determine how effective their teaching approaches were and to ascertain how students wanted to engage with the lesson. Interestingly, the very idea of incorporating students' voices in the classroom to customize learning for diverse needs and interests was advised by Rudduck and Flutter [61]. Teacher 4 (a trained special educator) would ask her students about the specific challenge they encountered and how they wanted her to help them for that day.

#### 3.4.1. (c) Ongoing Assessment and Sufficient Practice

Teacher 8 shared that she gave her students (one with ASD and the other who is hearing impaired) a lot of practice with the content. Sabaruddin et al. [56] also supported the use of repetition to enhance the mathematics achievement of students with ASD. She allowed them on occasions to create their own signs for complex mathematics principles for which no official sign was known. She also strongly supported the idea of reteaching. As is necessary she would do so until her students 'held' the information and could apply it accordingly. She said, however, in using the approach the teacher must be artful to use a different approach each time. For example, if a matching activity was used on day 1 to teach/reinforce a concept, on day 2 a colouring activity or some other technique should be used so that students do not become bored with learning. One teacher in the case study conducted by Sabaruddin et al. [56], recommended that mathematics learning for students with ASD should not be rushed or forced. Therefore, corroborating Teacher 8's stance. Teacher 8 also found the use of graphic organizers with her student with ASD to be effective. The latter confirmed the belief of Xin et al. [62] who recommended the use of graphic organizers to help students with special needs to better organize their thoughts and enhance their memory.

### 3.5 Results and Discussion Based on Research Question 4

*What types of training or information do teachers of mathematics need to successfully apply differentiated instruction?*

#### 3.5.1. Information and Training

Teachers 1, 2, 5 and 6 expressed a desire for more training in the use of differentiated instructions to support their struggling mathematics learners and/or those with exceptionalities. Teacher 2 wanted the trainer to provide sample mathematics lesson plans which clearly indicate specific differentiated approaches and wanted them to model such during the intensive workshops. Contrastingly, Teacher 5 said that she wanted to know more about differentiated approaches she could use and then she would implement it into her classroom based on her students' needs. That is, Teacher 5 did not need the trainer to model any specific technique but rather to provide her with information. Teacher 6, a special educator with no specialized mathematics training, was interested in improving her mathematics content and pedagogy, and wanted help in crafting lessons which appealed to both boys and girls. Her desire aligned with Van Geel et al. [59] who suggested that expert content knowledge is critical to the success of differentiated instructions and students' outcomes.

#### 3.5.2. Resources

Teachers 2, 3, 6, 7, and 8 would benefit from the acquisition and use of mathematics manipulatives, education technologies, and other resources. This finding is consistent with Brighton et al. [33] who conveyed that educators need tangible tools (e.g.: modern and adequate teaching aids) to aid in differentiating instructions. Teacher 2 lamented that the WIFI access at her school was unreliable and limited her ability to use websites and other online resources to enhance

the teaching and learning of mathematics. She also pointed to the limited or malfunctioning electrical sockets which also inhibited the use of technology. Tolentino [63] named technology integration as a key aspect of catering to students' diverse needs as it can assist with customizing instructions for students by using games and other applications. Teacher 3 saw where her students would benefit from having access to concrete mathematics manipulatives. Teacher 8 believed that having access to commercially made mathematics manipulatives and other resources for her students would enhance their learning. She said just as flash cards may be purchased to teach students the signs which accompany common vocabulary for Language Arts, similarly, such resources should be available with signs for secondary school mathematics principles to support students who are hearing impaired. Teacher 8 made her own resources, but it seemed logical that having these ready-made resources at her disposal would help her to focus on other critical areas of teaching and learning. Teacher 6 wanted the organizers of the mathematics workshops to supply the teachers with mathematics manipulatives and resources which they can use immediately with their students. She expressed her displeasure with workshops only providing participants with a certificate of participation which has no benefit to her students.

### 3.5.3. Support

Teachers 3 and 5 bemoaned the large class sizes with which they must contend. Although Teacher 5's classes did not exceed 15 students, she explained how difficult it was for her to support their needs during the allotted class time, and she had a support teacher (Teacher 4). The special education schools have set the standard in this regard as none of the teachers (Teachers 6, 7 or 8) had classes exceeding 10 students. Teachers 3, 4, 5 and 6 explained that the workload and inflexible timetables made collaboration (with other special educators or mathematics teachers) or even the ability to help their students outside of class time difficult to virtually impossible. Teacher 4, a special educator, wanted her school's administration to take the lead by ensuring that a specific time is set for collaboration among special and general educators, and that the general education trained mathematics teachers receive more training in the use of differentiated instructions. She thought directives from the leadership coupled with increased staff awareness could help her be more effective. To support Teacher 4's point, Goddard et al. [38] have established the critical role the school's administration plays in ensuring the use of differentiated instructions among their staff. This notion was also supported by Brighton et al. [33] who thought that teachers would be more inspired to differentiate instructions when they are given more flexible timetables and receive strong support from their school's administration.

### 3.6 Implications

The following reflects implications for practice and further research derived from the findings of this study.

The differentiated instructional (DI) approaches employed by the sample of teachers in this research may have, in the short term, been effective in supporting the needs of the Grade 7 and 8 struggling mathematics students and those

with exceptionalities. However, in the long run, because students with mathematics difficulties (MD) perform lower than their ordinary counterparts [5], the DI approaches may not be sufficient to significantly minimize or close the mathematics achievement gap of the students with MD when compared to average and high mathematics achievers. This implication is of importance because their lower performance could impede their ability to progress to career choices which require mathematics as a foundation or being able to function in society (e.g.: purchasing goods and services, banking etc.). Therefore, this research provides a framework for further research and tracking to be conducted among the sample of students taught by the participants to scientifically quantify the effectiveness of the differentiated approaches to achieve maximum impact. It amplifies the need for all mathematics educators to be trained in mathematics pedagogy and special education, particularly the latter as it relates to the specific category of students the educators will serve. For example, if the population of students the mathematics educator predominantly serves have autism or a learning disability then their training ought to support those exceptionalities.

Differentiated instruction is an effective approach for supporting learners, irrespective of grade level or subject area, according to a quantitative analysis of studies on DI across countries such as America, Africa, Asia and Europe from January 2010 to April 2023 [64]. AM et al., [64] also noted that the success of differentiated instruction (DI) implementation in those jurisdictions depended upon the country's cultural context and resources. Jamaican schools must, therefore, identify their own unique challenges, assess their pupils' needs, and provide ongoing staff training to effectively implement differentiated teaching for all mathematics students. It might be appropriate to concentrate on the following as part of the professional development: (a) differentiating mathematics lessons by components, starting with content followed by process, product and environment in subsequent sessions; (b) designing focused sessions to address specific DI approaches for a particular type of exceptionality such as support for children with learning disabilities; (c) focusing on various DI strategies, such as tiered assessments, and incorporating another such as choice in a future sessions. Training sessions should be conducted by subject-matter specialists with successful DI experience and provide readily applicable DI resources for novice instructors.

There is a need for administrators to explore reducing the teaching hours of mathematics educators so that quality time is afforded to them to engage in team planning sessions during the workday or to support students through one-on-one or small group after class consultation sessions. Despite MOESYI mandates, some secondary schools in Kingston and St. Andrew have implemented the recommendation to reduce teaching hours, resulting in positive outcomes.

Another implication of this study is the need for stakeholder collaboration. In addition to collaboration between the mainstream teacher and special educators (APSE coaches), successful implementation of differentiated instructions requires increased cooperation between teaching staff and parents (guardians or caregivers). Parents believe that DI is

beneficial to improving the social skills of their children among the academic benefits [57]. However, these parents noted the glaring deficits in meaningful collaboration among general and special education teachers. Schools that actively involve parents in their children's education, particularly those struggling with math and those with special needs, reap more advantages in the form of stronger support, parent buy-in, and student improvement.

#### 4. Conclusion

Differentiated instruction shows promise for improving mathematics performance among struggling learners and students with exceptionalities. However, effective implementation requires teacher training, adequate resources, and administrative support. Future research should explore its long-term impact on diverse learner outcomes.

#### 5. Recommendations

The findings and conclusions derived from this research have resulted in the following recommendations.

##### 5.1. Mathematics and Special Education Training

Knowledge of only differentiated mathematics instructions or training solely in special education are insufficient to record noticeable changes in the mathematics performance of students, let alone struggling learners and those with exceptionalities. Instead, blending the two specializations seems the best model to effect meaningful change in the mathematics outcome of Jamaican students. This can be achieved in two ways, by:

- a) Fostering, in the short-term, a collaborative inclusive school environment whereby mathematics educators and their assigned special educator are given sufficient time during the school day to discuss students' needs, to plan meaningful mathematics lessons and interventions, and to monitor students' progress.
- b) Ensuring that mathematics educators receive substantial training in special education or teachers in special education who will work alongside mathematics students receive adequate training in mathematics content and pedagogy. In the short term too, all teacher training institutions could mandate that all secondary mathematics student-teachers sit the course, Mathematics for Special Education. That course is currently being offered at about two of the eight Teachers Colleges' of Jamaica (TCJ) institutions. It is also possible for local teacher training institutions to explore offering double major option first and second degrees in Mathematics and Special Education to enable educators to use the much 'talked about' differentiated strategies to teach specific mathematics content and skills to students with exceptionalities. Scholarships may be offered to students who opt for this option to boost the number of people pursuing these degrees.

##### 5.2. Create Schools of Excellence

In these inclusive model schools, class sizes should be in keeping with current research, the required number of

special educators employed, and flexible teaching timetables implemented to facilitate ongoing collaboration among general education-trained mathematics teachers and special educators, along with parents and other MOESYI stakeholders. The MOESYI can track the progress of students in these schools, carefully examine the findings, and make the necessary adjustments for implementation in other schools.

##### 5.3. Resource Constraints

The study highlights the lack of resources in the effective use of DI, a problem also prevalent in other nations such as India [57]. Educational institutions should first identify the essential resources required for effectively implementing DI. They need to assess their current resources to initiate the process and seek funding for additional, costlier resources. Funding sources include the Digicel Foundation, the MOESYI, and its partners, such as UNICEF Jamaica, as well as fund-raising activities held by local schools.

##### 5.4. Expand Study for Quantitative Analysis at the Research Sites

This research was helpful in eliciting the first-hand lived experiences of the mathematics teachers and special educators. It can now be expanded to include all mathematics teachers at the Grades 7 and 8 levels at each research site, or among mathematics teachers across the entire school. The information gathered would help to determine, for instance, which barriers to the successful application of differentiated instructions during math classes are widespread or what are the real reasons for the students' underperformance. Quantitative research could be used to measure the impact of the use of specific differentiated instructional practices on students' mathematics performance. Therefore, teachers will have more statistical data on the effectiveness of their teaching strategies. Conducting a longitudinal quantitative or mixed-method analysis could be beneficial for monitoring students' performance and evaluating the effectiveness of differentiated intervention strategies.

#### 6. Limitations

Three limitations of this study were: (a) the lack of direct classroom observations which would assist in the collection of additional first-hand data and to validate the data obtained during the interviews, for instance, regarding the extent of the use of differentiated instructions; (b) the challenge experienced with obtaining willing participants who met the criteria for the study; and (c) the small sample size that limits the ability to make generalizations about the population. Expanding the sample size to include teachers, special educators, students, and parents could provide a more comprehensive understanding of the effectiveness of differentiated instruction in improving mathematics performance, especially for learners who have exceptionalities or struggle with math.

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### Author Profile



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