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Exploring the impact of differentiated and demonstration instructional methods on grade 7 integrated science learning in a secondary school in Guyana

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Abstract
This study presents the results of a preliminary investigation into the effectiveness of two pedagogical approaches in teaching Integrated Science to Grade 7 students within a classroom environment at a Secondary School in Region 6, Guyana. The study utilized a quasi-experimental design involving pre and post-tests to evaluate the cognitive learning outcomes of students. Nineteen students from one Grade 7 class were randomly divided into two groups, and taught for three weeks: Group 1 received instruction via the demonstration method, while Group 2 was taught using the differentiation method. Both groups were evaluated using a standardized 40-item multiple-choice test adapted from the Ministry of Education's Grade 7 Integrated Science consolidated curriculum. Results indicated that while both methods improved post-test performance, the differentiation method produced significantly higher gains, with a post-test mean of 27 (67%) compared to 21.5 (53.8%) for the demonstration group. The greater variance and standard deviation in the differentiation group suggested wider learning diversity but also enhancedd impact. A t-test yielded a statistically significant result ($t = 2.2$, $p = 0.04$), indicating a meaningful difference between the two instructional approaches. These findings suggest that differentiation may be a more effective strategy than demonstration for improving Integrated Science learning outcomes at the junior secondary level. The study contributes valuable insights into instructional design in Guyanese classrooms and reinforces the importance of tailoring teaching methods to student needs.

Keywords: Differentiated instruction, demonstration method, integrated science, cognitive learning outcome, Guyana

1. Introduction

Each student in a classroom environment has unique learning styles and interests and different learning sensory modalities. Teachers should consider these distinctions as they impact student learning, discipline, interaction, and achievement. As a result, a teacher's approach to delivering lessons in the classroom will influence students' learning outcomes [8, 30].
Generating student-centered lessons and developing strong relationships with students are critical components of preserving classroom discipline. Teachers can help students reach high academic and behavioral standards by emphasizing empathy, unconditional positive regard, authenticity, encouragement, and trust, all of which promote classroom cooperation. It is therefore necessary for teachers to create and implement lessons that demonstrate that students with various learning sensory abilities are accommodated [12].
It is important for students to collaborate in the classroom, especially when the goal is similar, and interacting with classmates fosters positive self-esteem, trust, and social skills while also broadening classroom friendships. In this regard students should be given task responsibilities and encouraged to be accountable, in an effort to boost their confidence [21].
Subsequently, how students are addressed in terms of learning determines their academic achievement. Students must first be motivated to learn, which requires the teacher to implement tactics to capture students' attention. This can be accomplished by identifying

each child's unique learning style and tailoring teachings to match their specific needs in the classroom [30].

Science is one of four key disciplines in the educational system that is concerned with the methodical investigation of the structure and behavior of the physical, social, and natural worlds via observation and experiments. Studying sciences increases creativity, develops critical thinking abilities, enhances communication skills, broadens our viewpoints, and, most significantly, fosters a love of learning. Every student, regardless of cognitive level, can learn science in the classroom, but it all depends on how the topics are delivered. To build a love for a subject, a student must be driven to learn it. However, in order for a student to be motivated to learn, their attention must first be garnered by means of either intrinsic or extrinsic forces. Therefore, it is critical for a teacher to make the lesson engaging in order to meet the demands of all students in the classroom with various cognitive skills.

A teacher can utilize a variety of strategies in the classroom for delivering lessons, including the inquiry method, inductive method, deductive method, demonstration method, and differentiation method. It is critical to select the best information delivery technique for each student's individual ability, because each strategy has advantages and disadvantages, and therefore should be adapted to a student's specific needs based on the lesson objectives.

Students learn more by doing than by watching [7], so a teacher should organize lessons in which students can participate as much as the teacher. The demonstration and differentiation approaches both address this requirement. Several research has been conducted on both methodologies, but no database exists that compares the effectiveness of the two teaching strategies in the classroom. Table 1 presents a comparison between the Demonstration and Differentiation methods used in the classroom environment.

Table 1: Comparison of demonstration and differentiation methods in classroom teaching

Feature	Demonstration Method	Differentiation Method
Definition	A visual approach to teaching where the teacher models processes, skills, or concepts to students.	A teaching strategy tailored to accommodate students' varying abilities, interests, and learning styles.
Main focus	Teacher-centered modeling of information, emphasizing visual and procedural clarity.	Student-centered learning that adapts content, process, and product based on individual learner needs.
Types	Method Demonstration (step-by-step explanation)-Result Demonstration (proof via sensory evidence)	No fixed types, but differentiated by content, process, product, or learning environment.
Student engagement	Students observe, ask questions, and draw conclusions during and after the demonstration.	Students are actively engaged in tasks suited to their learning profiles, promoting autonomy and participation.
Role of the teacher	Acts as a model and guide; demonstrates skills or processes.	Acts as a facilitator who plans and delivers personalized learning experiences.
Learning goals	Uniform for the class but delivered through a teacher-led visual or hands-on display.	Common goals for the class but approached through individualized strategies.
Flexibility in instruction	Limited flexibility; the focus is on clarity and standardization of demonstration.	Highly flexible; instruction varies to match students' readiness, interests, and learning profiles.
Evidence of learning	Based on students' ability to understand and replicate the demonstrated activity.	Based on how well students apply knowledge through varied tasks aligned to their strengths and needs.
Key benefit	Clarifies abstract or complex content through visualization and modeling.	Promotes inclusivity and supports diverse learners by optimizing individual student growth.
Author(s)	Giridharan & Raju (2016) [7]	Tucker (2022) [28]; Bhagarathi *et al.* (2025) [2]

This study investigated the impact of differentiation and demonstration approaches on student accomplishment in science classroom environments. The research questions that guided this study are:

1) How does the demonstration method and differentiation method impact the learning outcome of students?
2) Is there a significant difference between using the demonstration method and differentiation method on the students' performance?

2. Methodology

2.1 Research design

This study employed a quasi-experimental design utilizing a non-equivalent groups pre-test and post-test approach to investigate the effectiveness of two instructional methods, demonstration and differentiation, on students' cognitive learning outcomes in Integrated Science. The design was chosen because of the natural classroom setting, where random assignment of participants to different schools or classes was not feasible.

2.2 Description of study location and population

The study was conducted at Secondary School A located in Region 6, Guyana. The target population comprised all Grade 7B students enrolled at the institution during the academic term. The broader Grade 7 cohort consisted of approximately 92 students, divided into four (4) classes (7A-7D).

For this investigation, one class consisting of 19 students was purposively selected. Initially, the class included 24 students; however, five were no longer enrolled at the time of data collection due to transfers or withdrawal from the school. The final sample included 11 female and 8 male students. This group was deemed suitable for conducting a small-scale, preliminary comparison of instructional methods in a controlled classroom environment.

2.3 Intervention procedure

To minimize bias, students in the selected classroom were randomly assigned to two groups: Group 1, which received instruction through the demonstration method, and Group 2, which was taught using the differentiation method. To further ensure objectivity and maintain researcher neutrality, instruction for both groups was delivered by a senior teacher in the Science Department.

A pre-test was administered to all students prior to the intervention, to assess baseline knowledge. Instruction then proceeded over a three-week period, with each group receiving lessons tailored to their respective teaching method. For Group 2, the teacher incorporated various sensory modalities as part of the differentiated instruction, adapting strategies throughout the intervention to enhance its effectiveness.

At the end of the instructional period, a post-test, identical in structure and content to the pre-test, was administered to both groups. All data collected were subsequently analyzed and interpreted using descriptive statistical methods.

2.4 Instrumentation

The research instrument consisted of a 40-item multiple-choice test developed from the Grade 7 Integrated Science Consolidated Curriculum issued by the Ministry of Education, Guyana. The instrument was designed to assess students' cognitive abilities in the three (3) domains of the Bloom's Taxonomy (Remembering, Understanding, and Applying). The same instrument was used for both pre-test and post-test assessments to ensure consistency. Sample questions were created to match the relevant topics to that of the termly scheme of work.

2.5 Reliability of instrument

To ensure consistency and validity of instruction across the two groups, lesson plans were carefully designed and aligned with the Grade 7 Integrated Science Consolidated Curriculum developed by the Ministry of Education, Guyana. The instructional content focused on topics that were suitable for the students and aligned with the termly scheme of work. Two sets of lesson plans were generated as shown in Table 2.

Table 2: Basis for generating lesson plans for the two test groups

Group 1 (demonstration method)	Group 2 (differentiation method)
• Lessons involved teacher-led demonstrations using real-life examples and visual aids. • The teacher modeled scientific processes and concepts, allowing students to observe and listen with limited hands-on involvement. • This approach emphasized visual and auditory learning through structured teacher control.	• Lessons were adapted to cater to diverse learning styles and abilities. • Differentiated instruction included group activities, hands-on experiments, visual aids, simplified texts, and verbal scaffolding to meet the needs of individual learners. • Multiple sensory modalities were engaged, and students had increased opportunities for participation, peer discussion, and exploratory learning.

The instrument and lesson plans were reviewed and validated by the Graduate Head of the Science Department (GHOD) to ensure alignment with curriculum standards and learning objectives. The duration, objectives, activities, and assessment methods were consistent in both groups, with the mode of delivery being the primary variable.

2.6 Data analysis

Tables and graphs were generated using the Microsoft Excel 2016 and the Statistical Package for Social Sciences (SPSS) version 23 software programs to present all the data. The data was analyzed using descriptive techniques adopted from Hajar *et al*., (2021) [9]. The steps for analyzing the data includes creating a distribution of frequency and percentage values then classifying the effectiveness of the method as follows in Table 3 below.

Table 3: Classification of method effectiveness

No.	Score interval (%)	Performance category
1	85-100	Very high
2	70-84	High
3	56-69	Moderate
4	40-55	Low
5	0-39	Very low

$$t = \frac{Md}{\sqrt{\frac{\Sigma x^2 d}{N(N-1)}}}$$

Md = *The mean of the difference between pretest and posttest*
Xd = *deviation of each subject (d-Md)*
$\Sigma X^2 d$ = *the sum of the squares of the deviation*
N = *subjects on the sample*
Db = *determined by N-1*

To determine the significance difference between the pretest and post-test results of students' performance for the two methods, the t-test formula was used:

3. Results and Discussion

Table 4 depicts the scores obtained from students for the pre-test and post-test. According to the results, there is a mean average of 11.5 (28.75%) for the pre-test and mean average of 21.5 (53.8%) for the post test. This shows that there is an increase in performance. However, when looked at individually, one of the students scored one mark less in the post-test when compared to the pre-test. The one-mark decrease in the post-test score may be due to factors such as test fatigue, a lapse in concentration, or misinterpretation of a question. Minor fluctuations like this are common and do not necessarily indicate a decline in the student's understanding [5, 20, 31].

Table 4: Pre-test and post-test results from the demonstration group

Student	Pre-test result	Post-test result	Difference
01	11	21	10
02	10	24	14
03	9	18	9
04	13	31	18
05	10	24	14
06	11	24	13
07	13	12	-1
08	13	20	7
09	11	23	12
10	14	18	4
Total marks/ group	115	215	100
MEAN	11.5	21.5	10
Percentage (%)	28.75	53.8	20.05

Different studies, Von Korff *et al*., (2016) [29]; Barka & Danburam, (2020) [1]; Kaluba & Mbewe, (2023) [13];

Okhankhu, (2023) [17] and Hermawan *et al.*, (2024) [11], across diverse educational settings, have confirmed the effectiveness of the demonstration method in enhancing science learning outcomes. Hermawan *et al.*, (2024) [11] conducted a classroom action research study at SDN Kebagusan 02 Pagi in South Jakarta, Indonesia, where they implemented the demonstration method with a class of Grade 3 students. The study revealed a significant increase in learning outcomes, with mastery levels rising from 24% in the initial phase to 100% by the end of the intervention. The authors concluded that incorporating engaging props and varied media during demonstrations, made science concepts more accessible and memorable. They recommended that teachers use demonstrations creatively to improve student mastery of curriculum objectives.

Similarly, Okhankhu (2023) [17] examined the impact of demonstration and problem-solving methods on the academic performance of SS2 biology students in Edo State, Nigeria. Through a quasi-experimental design involving 100 students, the findings showed that those taught through demonstration outperformed their peers in the problem-solving group. The results, supported by a statistically significant p-value ($p = 0.003$), led to the recommendation that the demonstration method should be prioritized for teaching biology concepts, especially in contexts where conceptual clarity is essential. In a comparable study, Barka & Danburam (2020) [1] assessed the effectiveness of demonstration versus lecture-based teaching on agricultural science students in Adamawa State, Nigeria. Their study, which included over 700 students, showed that those in the demonstration group achieved significantly higher academic results. The authors emphasized the importance of adopting demonstration strategies widely and called for targeted teacher training programs to ensure effective implementation, especially in under-resourced schools.

Ekeyi (2013) [4] also reported positive results in a quasi-experimental study conducted in Kogi State, Nigeria. Working with 480 secondary school students, the study demonstrated that those taught the subject agricultural science through demonstration scored significantly higher than those taught through traditional lectures. Ekeyi concluded that demonstration should be integrated into science instruction for its capacity to facilitate hands-on engagement and retention. Supporting this, Kaluba & Mbewe (2023) [13] conducted a study in Lusaka District, Zambia, using demonstration-guided simulations to teach electromagnetic induction in physics. Their findings revealed not only improved performance across both male and female learners but also a significant increase in conceptual understanding. Notably, female students in the experimental group performed better than their control group counterparts. This led the authors to recommend demonstration-simulation methods as inclusive and effective teaching tools for science education.

McKee *et al.*, (2007) [15] conducted a study in the United States, evaluating the impact of demonstration-based laboratory instruction on science students' understanding. The study concluded that structured demonstrations contributed to improved conceptual learning and procedural competence. On a broader scale, Freeman *et al.*, (2014) [6] performed a meta-analysis of 228 studies in STEM education across various countries. Their analysis found that active learning methods, including demonstrations, increased exam performance by about six percentage points and reduced student failure rates by 50%. They recommended the widespread adoption of demonstration-rich instructional practices in science education. Similarly, Hake (1998) [10] analyzed data from over 6,000 students in introductory physics courses and found that students in demonstration-based and interactive engagement classes showed significantly higher conceptual gains compared to those in traditional lecture-based settings.

Von Korff *et al*., (2016) [29] analyzed classroom data from approximately 50,000 physics students across 62 classes and found that interactive strategies, including demonstration, were linked to higher levels of student understanding and engagement, regardless of class size or institutional context. They concluded that such approaches are universally beneficial and should be implemented across various science curricula. In 2020, Sumers *et al*., [27] explored the effectiveness of demonstration over verbal explanation in teaching complex concepts. Their experimental study indicated that demonstration remains more effective even when there is a mismatch in perception between teacher and student, while verbal explanations tend to lose clarity under such conditions. They concluded that demonstrations are a more robust and dependable instructional strategy, especially in visually or procedurally complex content areas. Together, these studies underscore the value of the demonstration method in science education across varying levels, subjects, and contexts. The collective findings suggest that demonstration not only enhances cognitive understanding but also supports gender inclusivity and engagement. It is recommended that educators receive targeted training in demonstration techniques and that science curricula be revised to incorporate demonstration-based learning as a core instructional strategy.

Table 5 depicts the scores obtained for the pre-test and post-test. According to the results, there is a mean average of 10. 7 (26.7%) for the pre-test and mean average of 27 (67%) for the post test. This shows that there is an increase in performance in the post-test compared to the pre-test.

Table 5: Pre-test and post-test results from the differentiation group

Student	Pre-test result	Post-test result	Difference
01	16	32	16
02	11	31	20
03	8	29	21
04	14	30	16
05	10	16	6
06	8	29	21
07	13	30	17
08	6	27	21
09	10	19	9
Total marks/ group	96	243	147
Mean	10.7	27	16.3
Percentage (%)	26.7	67	40.3

Figure 1 clearly show that there is greater percentage obtained from the demonstration method compared to the differentiation method. However, when compared to the results obtained to the post-test, the percentage was greater from the differentiation method as compared to the demonstration method. This shows that there is a difference between the results obtained from the demonstration and differentiation method.

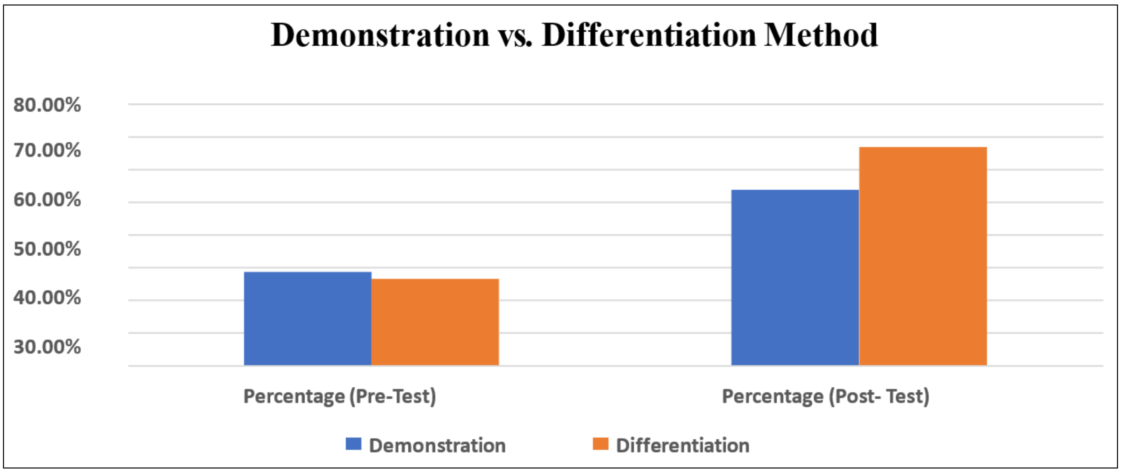

Fig 1: Comparison between the demonstration and differentiation method

Selden & Suryadhep (n.d.) [25] conducted a study in Bhutan involving Grade 5 students to evaluate the effectiveness of differentiated instruction in Science. Using a pre-test/post-test design, they found a statistically significant improvement in student performance, with mean scores rising from 8.58 to 14.37 ($p = .01$). The study also highlighted increased learner satisfaction, supporting the use of differentiated strategies to meet diverse student needs. In a Turkish study, Yurtseven *et al*., (2013) [32] examined the integration of differentiated instruction with Understanding by Design (UbD) in a Grade 6 Science classroom. Their embedded mixed-method design showed significant academic gains and heightened student engagement, suggesting that planning science instruction through UbD frameworks enhances the impact of differentiation.

A study by Bhagarathi *et al*., (2025) [2] in Guyana explored the effects of differentiated instruction compared to conventional methods on Grade 8 Science students in Region 6. Although the sample size was small, the differentiation group achieved a higher average post-test score (53.5%) than the control group (49%), indicating a positive trend. The authors recommended larger-scale investigations to strengthen the evidence base in the Guyanese context. Similarly, Kamarulzaman *et al*., (2024) [14] conducted qualitative research in Malaysia's mixed-ability STEM classrooms, emphasizing the importance of teacher readiness and curriculum alignment for effective differentiated instruction implementation. Teachers reported improved learning outcomes but identified the need for more support and professional development.

Gou & Singh (2024) [8] conducted a meta-analysis of 21 studies in higher education, focusing on differentiated methods such as content, process, and product adjustments. The analysis found a significant overall improvement in both student achievement and perceptions ($p<.001$), strongly endorsing differentiated instruction for postsecondary science education. In Belgium, Smets *et al*., (2022) [26] studied how secondary teachers adopted differentiated instruction practices over time. Their findings revealed that with structured support and contextual planning, teachers became more adept at tailoring instruction, resulting in more effective student-centered learning environments.

In the United States, Mehalik *et al*., (2008) [16] compared design-based learning, a differentiated, inquiry-driven approach, with scripted inquiry in middle school Science. Students exposed to design-based learning demonstrated deeper conceptual understanding and significantly higher scores, particularly among lower-achieving students. Freeman *et al*., (2014) [6] conducted a broad meta-analysis of 225 STEM studies and found that active learning (which includes differentiated strategies) reduced failure rates and significantly improved learning performance (average effect size ~0.47). Hake (1998) [10], in a landmark physics education study, showed that interactive engagement techniques resulted in nearly double the learning gains compared to traditional lectures, supporting the foundational principles of differentiation in science teaching.

Finally, Coubergs *et al*., (2019) [3] synthesized findings from European secondary school studies and concluded that differentiated instruction has small to moderate positive effects on student achievement. Though the review called for more robust empirical research, it affirmed the value of strategies such as tiered assignments and flexible grouping.

Collectively, these studies suggest that differentiated instruction significantly improves cognitive outcomes in Science education. They recommend wider implementation of differentiated instruction supported by professional training, curriculum adjustments, and classroom-level innovation to accommodate the diverse learning needs of students.

According to Hajar *et al*., (2021) [9], the percentage difference between the pre-test for both methods is within the 0-39 range which is considered to be low, however, the results obtained from the post- test from both methods is considered to be moderate because it is within the 56-69 range. There is no difference in the pre- test for both methods according to the percentage range but based on the percentages obtained between the two groups after the post test, there is a difference in the two methods.

Table 6 shows the post-test results, the t-test and significance difference between the two groups.

Table 6: Comparison between the demonstration and differentiation method

Calculations	Demonstration method	Differentiation method
Mean	21.5	27
Variance	25.38	31.5
Number of students	10	9
d.f.	16	
t-stat.	-2.238	
SD	7.866652	
p-Value	0.03957	

According to the calculations generated using excel and SPSS version 23, the mean value is 21. 5 for the demonstration group and for the differentiation group, it is 27. This indicates that there is a greater average mean for group 2 (differentiation method). The variance and standard deviation speak about the spread in the data, since the variance for group 2 (31.5) is larger than group 1(25.4) and the standard deviation is 7.8, this indicates there is a great variability between the two methods. For every t-stat., there is a p-Value, here the t-stat. is 2.2 and the p-Value is 0.04. Since the p-Value is less than 0.05, it is considered to be significant. Therefore, there is a significance difference between the two groups.

Selden & Sakulwongs (2024) [24], working with Grade 5 students in Bhutan, reported statistically significant improvements in science achievement for students exposed to differentiated instructions. Their study utilized a quasi-experimental design similar to that of Bhagarathi *et al.* (2025) [2] and also to this study, but the clear statistical outcomes suggest that differentiated instructions may be more effective when applied in earlier educational stages or within systems more structurally supportive of instructional adaptation. These findings reinforce the view that differentiated instructions, when carefully implemented and aligned with curriculum standards, it can significantly enhance student learning outcomes.

Rojo (2013) [22] and Pablico *et al*., (2017) [18] provided additional insights by integrating both qualitative and quantitative data. Rojo's study in the United States focused on the impact of DI in high school chemistry, noting modest gains in formative assessments and significant increases in student engagement and confidence. Similarly, Pablico and colleagues observed higher achievement levels in differentiated instruction classrooms, although statistical significance was not achieved. Both studies emphasized the affective benefits of differentiated instruction since it improved student motivation, self-efficacy, and classroom participation, which may not always be reflected in summative test scores. These qualitative improvements are essential for evaluating the holistic impact of differentiated instruction and suggest that its true benefits may extend beyond conventional academic metrics.

4. Conclusion

Based on the findings of this quasi-experimental study, it is evident that both instructional methods (demonstration and differentiation), contributed to improved student performance in Integrated Science, as reflected in the post-test scores. However, the differentiation method yielded a noticeably higher average gain in both raw scores and percentages compared to the demonstration method. This may be interpreted as the differentiated instruction, which caters to diverse learning styles and abilities through varied strategies and modalities, may be more effective in enhancing cognitive outcomes among Grade 7 students. The improvement from low to moderate performance categories, as per Hajar *et al*., (2021) [9], confirms that the instructional interventions positively influenced student learning.

The t-test analysis further supports the conclusion that a statistically significant difference exists between the two instructional approaches. With a calculated p-value of 0.03957, less than the 0.05 significance level, it can be inferred that the differentiation method had a greater impact on students' academic performance than the demonstration method. This result implies that instructional strategies that promote active student engagement, individualized support, and multi-sensory learning can play a crucial role in improving Science education at the secondary level, particularly in classrooms with mixed abilities and learning preferences.

4.1 Concerns, limitations and recommendations

When the t-stat. test was calculated, the result obtained a value of 2.238. While the study was limited to a small sample from a single classroom within a specific region, its findings offer valuable insights for teaching practices in similar educational settings. The observed gains underscore the potential of differentiated instruction to address the diverse cognitive needs of students and foster deeper understanding of scientific concepts. Future research with larger and more varied populations is recommended to generalize the findings and explore how differentiated strategies can be systematically integrated into Science curricula across Guyana's secondary schools.

It is also recommended that teachers not only use the differentiation method for those students with different learning sensory modalities, but rather as a strategy for better effective teaching. Teachers should be given professional development workshops and seminars on teaching the differentiated instructional method to see if the values of the findings correlate with this study, thus employ it in the development of their student's performance.

Further, implementation fidelity, and methodological robustness in evaluating instructional effectiveness is very integral. Therefore, it is recommended that future research should adopt longitudinal designs, and incorporate both quantitative and qualitative metrics to more comprehensively assess the impact of differentiated instruction in science classrooms across diverse educational systems.

Compliance with ethical standards

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Statement of ethical approval

Permission to conduct the study was formally obtained by the researcher from the Headmaster of the participating Secondary School A. The study was designed to adhere strictly to its stated research questions, with no element of deception involved. Ethical principles of voluntary participation, confidentiality, and academic integrity were maintained throughout the research process

Confidentiality of participants

Student participants were not required to provide any identifying information, such as their names, signatures, contact numbers, or any details that could trace back to them. The school involved in this research was not identified but is referred to as "Secondary School A" throughout the study to ensure anonymity and confidentiality.

Declaration of competing interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Disclosure of conflict of interest
The authors certify that this submission is original work and is not under review at any other publication. The authors hereby declare that this manuscript does not have any conflict of interest.

Statement of informed consent
The authors declare that informed consent was obtained from all individual participants included in the study. All work utilized in this study was fully cited and referenced so authors of prior researches are given their due credentials for their work.

Data availability
Data will be made available on request.

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References

1. Barka N, Danburam M. Effect of demonstration teaching method on academic performance of senior secondary school students in agricultural science in Adamawa State, Nigeria. J Assoc Vocat Tech Educ Niger. 2020;26(1).
2. Bhagarathi LK, Indardat A, De France N, Baksh A, Ally-Charles BR, Cossiah C. Comparing the effectiveness of differentiated instruction versus conventional (traditional) instruction on the performance of grade 8 integrated science students at a secondary school in region 6, Guyana: A preliminary study. Int J Adv Acad Stud. 2025;7(3):103-113. https://doi.org/10.33545/27068919.2025.v7.i3b.1402
3. Coubergs C, Engels N, Struyven K, den Brok P. Differentiated instruction in secondary education: A systematic review of research evidence. Front Psychol. 2019;10:2366. https://doi.org/10.3389/fpsyg.2019.02366
4. Ekeyi DN. Effect of demonstration method of teaching on students' achievement in agricultural science. World J Educ. 2013;3(6):1-7. https://doi.org/10.5430/wje.v3n6p1
5. Eysenck MW, Derakshan N, Santos R, Calvo MG. Anxiety and cognitive performance: Attentional control theory. Emotion. 2007;7(2):336-353. https://doi.org/10.1037/1528-3542.7.2.336
6. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, *et al.* Active learning increases student performance in science, engineering and mathematics. Proc Natl Acad Sci U S A. 2014;111(23):8410-8415. https://doi.org/10.1073/pnas.1319030111
7. Giridharan K, Raju R. Impact of teaching strategies: Demonstration and lecture strategies and impact of teacher effect on academic achievement in engineering education. Int J Educ Sci. 2016;14(3):174-186.
8. Gou T, Singh S. The impact of differentiation methods (content, process, product) of differentiated instruction on the achievement and perception of students in higher education: A meta-analysis. Int J Acad Res Environ Geogr. 2024;14(11):2303-2320.
9. Hajar MS, Ahmad NS, Rahman AA, Ismail HN. Comparative effectiveness of teaching methods using pre-test and post-test performance: A case study. Int J Acad Res Prog Educ Dev. 2021;10(3):112-125. https://doi.org/10.6007/IJARPED/v10-i3/12345
10. Hake RR. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics' test data for introductory physics courses. Am J Phys. 1998;66(1):64-74. https://doi.org/10.1119/1.18809
11. Hermawan CM, Hesti, Anjani LS, Fuadah SF, Gani IA, Rosfiani O. Utilizing the demonstration method to enhance science learning outcomes: A classroom action research at SDN Kebagusan 02 Pagi, South Jakarta. Edutrend J Emerg Issues Trends Educ. 2024;1(2):92-107.
12. Jackson J, Sweetland J. Inspired issue brief; 2007. Available from: https://inspiredteaching.org/wp-content/uploads/impact-research-briefs-relationship-based-discipline.pdf
13. Kaluba C, Mbewe S. Efficacy of demonstration-guided simulations on male and female learners' conceptual understanding: Lessons from electromagnetic induction in selected secondary schools of Lusaka District. Int J Res Innov Soc Sci. 2023;7(3):1038-1053.
14. Kamarulzaman MH, Mariadass MEA, Kamarudin MF. Differentiated instruction for the teaching of STEM among mixed-ability students. Int J Res Innov Soc Sci. 2024;8(6):645-661.
15. McKee E, Williamson VM, Ruebush LE. Effects of demonstration laboratory on student learning. J Sci Educ Technol. 2007;16(5):395-400. https://doi.org/10.1007/s10956-007-9068-4
16. Mehalik MM, Doppelt Y, Schunn CD. Middle-school science through design-based learning versus scripted inquiry: Better overall science concept learning and equity gap reduction. J Eng Educ. 2008;97(1):71-85. https://doi.org/10.1002/j.2168-9830.2008.tb00955.x
17. Okhankhu EP. Efficacy of demonstration and problem-solving teaching methods on biology students' academic performance in Esan-West L.G.A of Edo State. J Educ Dev Areas. 2023;29(1).
18. Pablico JR, Diack M, Lawson A. Differentiated instruction in the high school science classroom: Qualitative and quantitative analyses. Int J Learn Teach Educ Res.; 2017.
19. Paschler H, McDaniel M, Rohrer D, Bjork R. Learning styles: Concepts and evidence. Psychol Sci Public Interest. 2010;9:105-119. https://inspiredteaching.org/wp-content/uploads/impact-research-briefs-relationship-based-discipline.pdf
20. Pope NG. How the time of day affects productivity: Evidence from school schedules. Rev Econ Stat. 2016;98(1):1-11. https://doi.org/10.1162/REST_a_00525
21. Rigacci A. What is cooperative learning? Five strategies for your classroom; 2022. Available from: https://www.teacheracademy.eu/blog/cooperative-learning-strategies/

22. Rojo P. Studying the effects of differentiated instruction in the science classroom. Bozeman (MT): Montana State University; 2013. Available from: Montana State digital repository.
23. School & College Listings. Central Corentyne Secondary School. Available from: https://www.schoolandcollegelistings.com/GY/Bush-Lot-Village/1407277829521730/Central-Corentyne-Secondary-School
24. Selden C, Sakulwongs N. The effectiveness of using differentiated instruction on science learning achievement for grade 5 Bhutanese students. J Res Curric Dev. 2024;14(2):32-43.
25. Selden C, Suryadhep NS. The effectiveness of using differentiated instruction on science learning achievement for Grade 5 Bhutanese students. J Res Curric Dev. Available from: https://so03.tci-thaijo.org/index.php/jrcd/article/view/280916
26. Smets W, De Neve D, Struyven K. Responding to students' learning needs: How secondary education teachers learn to implement differentiated instruction. Educ Action Res. 2022;30(2):243-260. https://doi.org/10.1080/09650792.2021.1932809
27. Sumers TR, Ho MK, Griffiths TL. Show or tell? Demonstration is more robust to changes in shared perception than explanation. arXiv; 2020. Available from: https://arxiv.org/abs/2012.09035
28. Tucker GC. What is differentiated instruction? 2022. Available from: https://www.understood.org/en/articles/differentiated-instruction-what-you-need-to-know
29. Von Korff J, Archibeque B, Gomez KA, Heckendorf T, McKagan SB, Sayre EC, *et al*. Secondary analysis of teaching methods in introductory physics: A 50k-student study. arXiv; 2016. Available from: https://arxiv.org/abs/1603.00516
30. Weimer M. Learner-centered teaching: Five key changes to practice. 2nd ed. San Francisco (CA): Jossey-Bass; 2012.
31. Wise SL, DeMars CE. Low examinee effort in low-stakes assessment: Problems and potential solutions. Educ Assess. 2005;10(1):1-17. https://doi.org/10.1207/s15326977ea1001_1
32. Yurtseven N, Doğan S, Altun S. Planning differentiated science instruction using Understanding by Design: The case of Turkey. Procedia Soc Behav Sci. 2013;106:4041-4045. https://doi.org/10.1016/j.sbspro.2013.12.460