

UNIVERSITY OF EDUCATION, WINNEBA

**INVESTIGATING THE EFFECT OF DIFFERENTIATED INSTRUCTION
ON THE ACADEMIC PERFORMANCE OF SENIOR HIGH SCHOOL
STUDENTS IN SELECTED CONCEPTS IN INTEGRATED SCIENCE**



**A thesis in the Department of Integrated Science Education,
Faculty of Science Education, submitted to the School of
Graduate Studies, in partial fulfilment
of the requirements for the award of the degree of
Master of Philosophy
(Integrated Science Education)
In the University of Education, Winneba**

SEPTEMBER, 2025

DECLARATION

STUDENT'S DECLARATION

I, **Kwowe Morgan Abago**, hereby declare that except for references to other people's work which have been duly identified and acknowledged, this research work is the slut of my own work and that it has neither in part nor whole been presented elsewhere.

.....
STUDENT'S SIGNATURE

.....
DATE

SUPERVISOR'S DECLARATION

I, **Dr James Awuni Azure**, hereby declare that the preparation and presentation of this work were supervised in accordance with the guidelines for supervision of research work as laid down by the School of Research and Graduate Studies, University of Education, Winneba.

.....
SUPERVISOR'S SIGNATURE

.....
DATE

DEDICATION

I lovingly dedicate this work to my dear parents, Mr and Mrs Kwowe, whose unwavering support and encouragement have been a constant source of strength. And to my beloved wife, whose love and understanding sustained me through this journey.



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My sincere thanks go to all the lecturers of the Integrated Science Department at the University of Education, Winneba, for the knowledge imparted and the guidance offered throughout my studies.

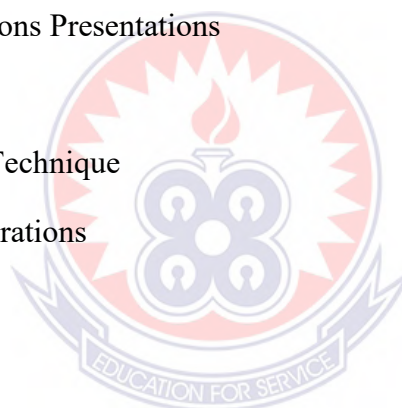
Finally, I acknowledge with deep appreciation all the authors and researchers whose works I have cited. Your contributions provided valuable insights and inspiration, which greatly enriched the quality of this work.

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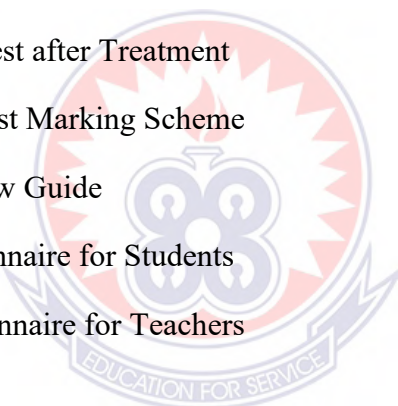
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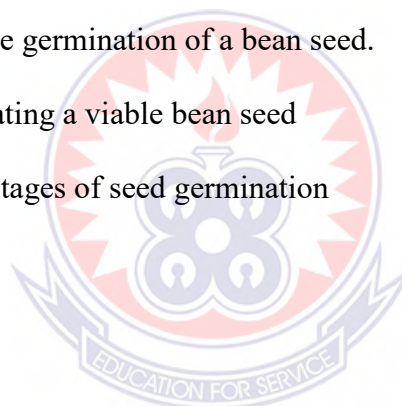
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ABSTRACT

This study investigated the effect of differentiated instruction (DI) on the academic performance of senior high school students in selected concepts of Integrated Science. The research was conducted at Paga Senior High School and Nabango Senior High Technical School, located in the Kasena-Nankana West District of the Upper East Region of Ghana. Fifteen (15) teachers were featured in the study. A total of 44 Form Two General Arts 2 students from both schools were purposively selected for the study. Purposive sampling was employed due to the nature of the sample size. Students were divided into experimental and control groups. The control group received instruction using traditional teaching methods in three separate sessions, whereas the experimental group was taught using differentiated instructional strategies. The study used a mixed-methods approach, employing tests, interviews, and questionnaires as research instruments. Quantitative data were analysed using descriptive and inferential statistics, while qualitative data were analysed thematically. The study addressed three research questions. Specifically, (1) the effect of DI on students' performance in rusting of iron, force, and seed germination, (2) students' attitudes towards DI, and (3) the challenges teachers face in implementing DI. A quasi-experimental design was employed, involving pre- and post-tests administered to experimental ($n = 29$) and control ($n = 15$) groups. An independent samples t-test on pre-test scores revealed no statistically significant difference between the groups, $t(42) = .14$, $p = .89$, $d = .04$, confirming academic equivalence at baseline. However, post-test results showed a significant difference in favour of the experimental group, $t(42) = 2.21$, $p = .03$, $d = .71$, indicating that DI positively affected student performance. Quantitative survey indicated that most students have a positive attitude towards DI, with increased engagement, motivation, and interest in learning. Qualitative analysis highlighted benefits such as enhanced understanding through active learning and real-life connections. Teacher responses identified major challenges in implementing DI, including time constraints, large class sizes, lack of resources, and limited professional development. It was concluded that DI is an effective instructional strategy for improving academic outcomes in Integrated Science concepts. The study recommended that Integrated Science teachers should adopt DI in teaching and learning the three concepts to maximise students' performance.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background and purpose of the study, the problem statement, research objectives, and questions. It also outlines the study's significance, limitations, scope and delimitations, as well as provides a list of acronyms, definitions of key terms, and organisation of the study.

1.1 Background of the Study

Science has made significant contributions to numerous aspects of life, including medicine, geophysics, hydrology, agriculture, communication, technology, education, transportation, and healthcare, to name a few. The value of science to humanity cannot be emphasised. Integrated Science is a course that blends many scientific disciplines to provide pupils with a thorough grasp of the natural world (Bybee, 2010). It includes topics like biology, chemistry, physics, and environmental science, among others. Differentiated instruction is critical for effectively delivering this knowledge and improving students' performance (Walton, 2017). Policymakers and researchers urge teachers to embrace diversity and to adapt their instruction to the diverse learning needs of students in their classrooms (Schleicher, 2016; UNESCO, 2017).

Respondent classrooms, where students are encouraged in their learning and treated as distinct individuals, improve students' attitudes and academic achievement (Ryan & Cooper, 2023). By using differentiated instruction, teachers can adapt their lessons to each student's unique needs in response to this variety (Tomlinson 2014). Differentiation involves adjusting instruction to address the diverse needs of each learner. The learning environment, materials, methods, and products can be

differentiated by teachers based on the learning profile, student interest, or readiness. Every learner achieves learning outcomes when differentiated instruction is used.

The idea behind differentiated learning is that every student responds to instruction differently and in their own unique way. As a result, a one-size-fits-all approach reduces the chances that students will gain from the instructional methods used in the classroom. Teachers who employ differentiated instruction consider several factors of their students to best suit their educational needs. To better assess students' personal traits and academic abilities, three diagnostic formative components are used: learning profile, interest, and preparedness (Tomlinson, 2001).

A differentiated instructor arranges education based on the needs of individual pupils rather than a predefined curriculum (Alnahdi et al., 2021). Teachers must acknowledge that students differ from different perspectives to plan and design curricula that are tailored to the students' interests and skills, using a variety of methods to present the lessons with varying complexity. Considering the significance of differentiated instruction in present-day varied classrooms, the recent study sought to investigate the approach's effectiveness with senior high school students.

According to Boelens et al. (2018), differentiation occurs at two distinct levels: administrative and classroom. The administrative level considers factors such as learners' socioeconomic status and gender. Classroom-level differentiation, on the other hand, focuses on content, process, product, and outcomes. At the content level, teachers adjust their instruction to better meet the diverse needs of their students.

Research has investigated several facets of differentiated instruction, including its theoretical basis and its general efficacy across various subjects (Zerai et., 2021).

However, there is insufficient empirical evidence relating varied instructional practices to enhanced academic outcomes, particularly selected concepts in Integrated Science.

In recent years, the educational landscape has evolved significantly, with a growing recognition of the importance of catering to diverse learning needs within classrooms. Differentiated instruction, a pedagogical approach that tailors teaching methods and materials to accommodate varying student abilities, interests, and learning profiles, has emerged as a promising strategy to enhance student engagement and academic success. This approach is particularly relevant in subjects such as Integrated Science, where complex concepts require varied instructional strategies to ensure comprehension among all learners (Schwab et al., 2020a, 2020b).

According to Ako et al. (2019) and Mohammed (2021), traditional teaching approaches frequently take centre stage, resulting in a one-size-fits-all strategy that might not adequately support all students. Some students might have trouble grasping important scientific ideas, which can affect their academic performance and interest in the subject matter (Subban, 2020).

According to the Ministry of Education's Medium-Term Expenditure Framework (MTEF) report for 2017–2019 (GES, 2017), recent efforts have been directed toward improving the quality of science teaching and learning in response to consistently poor student performance in the subject. The report highlights that students often struggle with understanding and applying scientific concepts, which negatively impacts their overall achievement in science. According to the Chief Examiner's report (West African Examinations Council, 2021, 2022, 2023, 2024) students' performance in Integrated Science has declined in senior high schools in Ghana. Indeed, per the report, the general performance of SHS students across the country has declined in recent years.

Thus, per the report, it is clearer that poor students' performance in Integrated Science in Ghanaian schools has made parents and other stakeholders in education raise questions about Integrated Science education. During an interaction with SHS2 General Art2 students in both Paga SHS and Nabango SHTS, the researcher revealed that the students had always found integrated science lessons to be boring, abstract, and too theoretical, which contributed to their underperformance in integrated science as a subject.

Therefore, the researcher focuses his study on evaluating the effect of differentiated instruction on students' academic performance in Integrated Science (Selected Concepts) at Paga Senior High and Nabango Senior High Technical in the Kasena-Nankana West District.

1.2 Statement of the Problem

Most Ghanaian educators still teach the same concept to all their pupils using the same approach (Ako et al., 2019; Mohammed, 2021). It is thought that delivering lessons using a single instructional technique ignores the various learning demands of each student in the class (Subban, 2020). Indeed, classroom instructions that employ the lecture method do not favour most students. This case is not different at Paga Senior High School and Nabango Senior High Technical School in the Kasena-Nankana West District.

Based on the researcher's classroom observations and analysis, students' interest and engagement, and class performance in Integrated Science concepts did not actually meet the expected outcomes of the lessons. Consequently, students in Integrated Science classes do not receive the personalised support they need to thrive academically.

Differentiated instruction may have advantages, but its precise impact on the academic performance of SHS students in integrated science is yet unclear. The extent to which varied instruction approaches lead to better learning outcomes in this subject area has not been thoroughly studied in the limited literature. This lack of comprehensive understanding indicates a need for further investigation into the specific strategies that effectively enhance student learning in Integrated Science and how these strategies can be adapted to cater for individual student needs.

As a result, the researcher intends to thoroughly investigate how differentiated instruction affects senior high school students' academic performance on the selected concepts in Integrated Science in the Kasena-Nankana West District.

1.3 Purpose of the Study

The purpose of this study was to investigate the effect of differentiated instruction on the academic performance of SHS students on 'Selected concepts' in Integrated Science within the Kasena-Nankana West District.

1.4 Objectives of the Study

The Specific objectives that the study addressed are to:

1. Determine the effect of differentiated instructional strategies on students' academic performance on 'Selected Concepts' in Integrated Science.
2. Investigate students' attitudes towards the use of differentiated learning approaches in the teaching and learning of 'Selected Concepts' in Integrated Science.
3. Examine the challenges that teachers encounter when implementing a differentiated instructional approach in the teaching and learning of Integrated Science.

1.5 Research Questions

To guide this study, the following research questions were formulated:

1. What is the effect of differentiated instruction on students' academic performance on 'Selected Concepts' in Integrated Science?
2. What attitudes do students have regarding the use of differentiated instruction strategies in the teaching and learning of 'Selected Concepts' in Integrated Science lessons?
3. What challenges do teachers face in employing differentiated instructional approach in the teaching and learning of Integrated Science?

1.6 Null Hypothesis

(H₀₁): There is no statistically significant difference in academic performance of students in the pre-test scores between both groups before treatment ($\mu_1 = \mu_2$).

(H₀₂): There is no statistically significant difference in students' academic performance in the post-test scores between those taught using DI and those taught using traditional teaching methods.

1.7 Significance of the Study

The findings of this research will contribute to the existing body of knowledge on varied instructional strategies in teaching Integrated Science concepts. The study holds significant implications for various stakeholders, especially educators in the education sector. Thus, it provides evidence-based insights into effective teaching practices that can be adopted to improve student engagement and performance in Integrated Science concepts. Investigating student attitudes toward differentiated instruction, the study can inform curriculum developers on how to create more inclusive educational materials that cater to multiple learning needs. Additionally, identifying the difficulties faced by

teachers would help build focused professional development programs that provide educators with the skills and tools they need to successfully conduct differentiated instruction. Again, this study can help create an atmosphere in the classroom that encourages all children to achieve academic success in Paga SHS and Nabango SHTS.

Though this study will not cover all the students in the schools in this country, it is in the view that the outcome of the study will provide informed ideas to Ghana Education Service (GES), the Ministry of Education (MOE), Centre for Curriculum Development, and the National Council for Curriculum Assessment (NaCCA).

1.8 Limitations of the Study

The study was limited by both time and financial constraints, which restricted the sample to only second-year General Arts Two students from Paga Senior High School and Nabango Senior High Technical School. Consequently, the relatively small sample size limits the extent to which the findings can be generalised to larger populations within the region or across Ghana.

Another limitation was student absenteeism, which posed a challenge to the researcher during data collection, as some participants were unavailable at various points of the study. This inconsistency in attendance may have influenced the reliability of the data gathered.

While the study investigated the effect of differentiated instruction on students' performance in Integrated Science concepts, its findings may not be fully generalisable to other subject areas or educational contexts. This is due to the specific local factors, such as classroom conditions and teaching dynamics, which shaped the conduct and outcomes of the research.

1.9 Scope and Delimitation

The scope of this study is limited to two senior high schools, Paga Senior High and Nabango Senior High, within the Kasena-Nankana West District. This study focused on only SHS2 General Art 2 students in the two senior high schools. The study was based on only the Selected concepts (Corrosion and rusting of iron, Force and Germination of seed) in Integrated Science. The study could have covered all the students of other classes in the two schools instead. The researcher exclusively conducted the study only on Form two General Art two students from both schools to obtain accurate and reliable data for his analysis, as those classes have with average class size that can easily be accessed for the purpose.

1.10 Acronyms

DI- Differentiated Instruction

MTEF - Ministry of Education's Medium Term Expenditure Framework

GES - Ghana Education Service

MOE- Ministry of Education

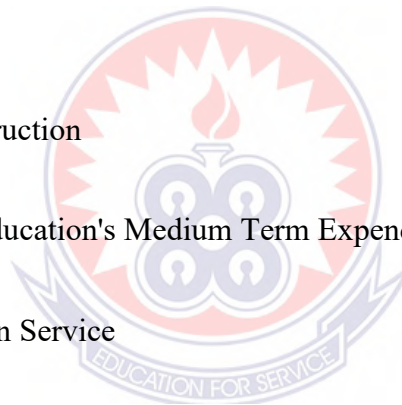
CCD – Centre for Curriculum Development

NaCCA – National Council for Curriculum Assessment

SHS - Senior High School

SHTS – Senior High Technical School

WASSCE - West African Senior School Certificate Examination



1.11 Definition of Terms

Differentiated Instruction Is an educational technique that involves tailoring instructional methods and resources to meet different student requirements and learning styles.

Academic Performance: The measurable outcome of a student's learning, often assessed through tests, assignments, and overall grades.

Integrated Science: A subject that combines various scientific disciplines such as biology, chemistry, and physics into a cohesive curriculum aimed at fostering scientific literacy.

Content: The information or material that students use to learn. What is taught or what the student needs to learn.

Process: Is how students learn. Activities in which the student engages to make sense of or master the content. How it is taught.

Product: Is how students demonstrate what they have learned after a lesson. Students to practice or apply the knowledge they have gained from a unit.

Learning environment: The physical area and arrangement of the classroom make up the learning environment. It is the atmosphere and operation of the classroom.

1.12 Organisation of the Study

The study is organised into five chapters. The first chapter introduces the background, problem statement, purpose, objectives, research questions, significance, limitations, scope, and delimitations, acronyms, and important term definitions. Chapter Two reviews the literature on differentiated instruction and its effects on academic performance. Chapter Three discusses the methodology used in the study. The results

and analysis of data collected from participants are reported in Chapter Four. Finally, Chapter Five discusses the findings, their implications for practice, future research recommendations, and a summary of the study's important findings.



CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter provides an overview of the body of research on differentiated instruction, its theoretical basis, and effects on students' academic achievement in Integrated Science. The chapter contains several studies that emphasise the value of differentiated instruction, the tactics used, and the difficulties teachers encounter when putting this strategy into practice. Students' perceptions of varied instruction and their value in creating inclusive learning environments are examined. The chapter ends with a conceptual framework of differentiated instruction.

2.1 Theoretical Framework of the Study

The concept of Universal Design for Learning (UDL) was developed by the Centre for Applied Special Technology (CAST) in the early 1990s as a response to the growing need for more inclusive and flexible educational frameworks. According to CAST (2010), UDL is a research-based framework aimed at designing curricula that accommodate the diverse learning needs of all individuals by promoting equal opportunities to acquire knowledge, develop skills, and cultivate a lifelong love of learning. The UDL approach proactively addresses barriers to learning by embedding multiple means of representation, engagement, and expression into the curriculum. This ensures that instructional goals, methods, materials, and assessments are accessible and effective for a broad range of learners, including those with disabilities or learning difficulties. More recently, UDL has gained recognition as a valuable strategy for supporting students who struggle in traditional educational settings by equipping them with the tools and opportunities necessary for meaningful participation and success. The framework fundamentally challenges conventional, one-size-fits-all curricular

models that prioritise uniformity and limit how students can engage with content, express their understanding, or demonstrate learning. Instead, UDL encourages educators to design learning experiences that are responsive to individual variability, thereby fostering inclusive classrooms that uphold high academic standards while embracing diversity in how students learn and succeed.

According to Firchow (2023), a universally designed curriculum “adapts to the student and his or her needs.” This concept highlights the importance of acknowledging student diversity in the classroom and tailoring instructional strategies accordingly. The development of differentiated instruction (DI) was influenced by Vygotsky’s sociocultural theory of learning. This theory posits that when students collaborate with more experienced peers to complete a task, they enter the zone of proximal development (ZPD) (Borja et al., 2015; Vygotsky, 1962). This zone supports learners in completing a task once they have strengthened their abilities by collaborating with a more knowledgeable student or being supervised by an adult. According to Cognitive Load Theory (CLT) by Sweller (2011), an instructional strategy is the worked example effect, where learners are presented with fully solved problems before attempting similar tasks independently.

In DI, scaffolding, responsive instruction, and student-teacher or student-student interaction are therefore important considerations (Subban, 2006). More significantly, educators must become more knowledgeable and understand that the "one size fits all" approach no longer yields useful outcomes. The implementation of DI is facilitated by strategies including "identifying student readiness; making modifications to the instructional content, process, and product; and enhancing collaboration and autonomy in learning," according to Pham (2012). These strategies ultimately lead to higher rates of student success.

Lesson plans and curricula should therefore be developed to take into consideration the needs, interests, and learning styles of the students in the classroom. "As many faces as it has practitioners and as many outcomes as there are learners" is another way to describe differentiation (Pettig, 2000).

Differentiated instruction is based on a variety of educational theories that emphasise the necessity of meeting the needs of learners differently.

2.1.1 Constructivism

According to constructivist theory, students build their knowledge from experiences and interactions with their environment. This theory promotes differentiated instruction by advocating for instructional strategies that enable students to engage with knowledge in meaningful ways. According to Piaget (1976), learners move through phases of cognitive development, and differentiated instruction can facilitate progression in learning. Piaget's (1972) cognitive developmental theory profoundly influenced educational thought, emphasising that children learn best through active engagement with their environment rather than passive reception of knowledge. When a learner interacts with others, it stimulates cognitive conflict and promotes equilibration.

2.1.2 Multiple intelligences theory

According to Gardner's (1983) theory of multiple intelligences, human intelligence is not a single, fixed capacity but rather a diverse set of cognitive abilities. Gardner identifies at least nine distinct types of intelligence: linguistic, logical-mathematical, spatial, bodily-kinaesthetic, musical, interpersonal, intrapersonal, naturalistic, and existential. Everyone possesses a unique combination of these intelligences, which shapes how they learn, communicate, and interact with the world. This theory challenges traditional views of intelligence that prioritise linguistic and mathematical

abilities, emphasizing instead the importance of recognising and nurturing multiple forms of intellectual strengths in educational settings. Differentiated instruction aligns with this theory by enabling educators to modify their teaching strategies to address these varied intelligences, thereby enhancing student engagement and comprehension. Gardner (1983) suggests that intelligence encompasses the capacity to solve problems, create products, and provide services that hold value within a diverse society. In this context, differentiated instruction seeks to equip students with problem-solving skills and the ability to produce meaningful work relevant to the subject matter.

2.1.3 Vygotsky's social development theory

The Zone of Proximal Development (ZPD) was first proposed by Vygotsky in 1978, who also highlighted the importance of social interactions in learning. Through collaborative learning experiences and the provision of suitable scaffolding and support based on individual requirements, differentiated instruction can successfully target students' ZPDs. Vygotsky was determined that children actively construct knowledge. Vygotsky emphasised the importance of culture and social interaction in the learning process. According to Vygotsky (1978), learning is a process rather than a product. According to Vygotsky, learning is a social process that involves both collaboration and guided interaction. Knowledge is constructed through communication, discussion, and the comparison of ideas with others in the learning environment, including teachers and more knowledgeable peers. This social engagement supports the child's cognitive development. Vygotsky emphasised the distinction between what a child can learn independently and what they can achieve with support from adults or skilled peers, a concept known as the Zone of Proximal Development (ZPD). He asserted that while children can reach the lower boundary of the ZPD on their own, they require guidance to attain the higher levels of development. According to the theory of Vygotsky (1978),

by adjusting the level of guidance and support provided, the teacher can help the student progress from where he is to a stage where he can accomplish. Discussion is used to reach the ZPD. The theory influences how instruction is differentiated. This approach focuses on social interaction, which affects relations between students and between students and teachers. This also encourages group learning, which is helpful for differentiated instruction.

2.2 Nature of Integrated Science

Integrated science education involves the coordinated teaching of multiple scientific disciplines, including physics, chemistry, biology, and agricultural science (Abd-EI-Khalick & BouJaoude, 1997). This interdisciplinary approach aims to provide students with a comprehensive understanding of scientific concepts and their real-world applications (Abd-EI-Khalick & BouJaoude, 1997; Bybee, 2010). Integrated science prepares students for advanced studies and careers in STEM fields by promoting interdisciplinary thinking (National Research Council, 2012, National Science Board, 2018). Research showed that integrated curricula can enhance student engagement and motivation as they frequent include hands-on activities and real-world applications (Becker & Park, 2011). However, the effective teaching and learning of integrated science face several persistent challenges, particularly in developing educational contexts. Numerous studies have highlighted a range of factors that negatively impact the quality of science education. These include inadequate teacher preparation and professional development, insufficient availability of instructional materials, and the use of inappropriate languages or media of instruction that hinder comprehension. Additionally, ineffective supervision and monitoring by school administrators, low levels of teacher motivation, and a shortage of qualified science educators contribute to gaps in instructional quality. Student-related factors, such as negative attitudes toward

science and a general lack of interest in scientific subjects, further exacerbate the problem (Anamuah-Mensah et al., 2017; Ngman-Wara, 2015). The studies indicated that addressing these multifaceted issues is essential to improving science outcomes and fostering scientific literacy among learners.

Certain Scientific topics can be appropriately handled by the students and even better understood when they engage in group discussions and group work (Azure, 2018). Azure further asserts that some topics in the integrated science syllabus are expected to provide challenges to the students; hence, they will need the help of knowledgeable colleagues. Taylor et al. (2021) discovered that school-related factors causing low performance in Integrated Science among students include inadequate resources, poor condition of existing facilities, general disruptions in class, and ineffective instructor supervision.

2.3 Differentiated Instruction (DI)

Differentiated instruction (DI) is an instructional strategy that acknowledges and addresses variations in students' learning styles, abilities, and other factors to maximise their learning potential. Differentiated instruction (DI) fosters meaningful learner engagement and promotes a personal connection to the learning process by allowing students to progress at their own pace while addressing their individual needs within a shared classroom environment (Magableh & Abdullah, 2020; Tomlinson, 2001, 2004, 2014; Tomlinson & Imbeau, 2010). By recognising and responding to the diverse abilities, interests, and learning profiles of students, DI creates more equitable and effective learning experiences. Studies have shown that when instruction is tailored to individual learner differences, students demonstrate greater academic achievement, increased motivation, and deeper conceptual understanding (Aliakbari & Haghghi, 2014; Hernández-Chérrez et al., 2020; Karadag & Yasar, 2010; Servilio, 2009; Tulbure,

2011). These findings underscore the potential of DI to transform traditional instructional practices and support the success of all learners, regardless of background or ability.

Expanding on this perspective, Boelens et al. (2018) identify two distinct levels of differentiation: administrative and classroom based. Administrative-level differentiation addresses broader systemic factors such as students' socioeconomic backgrounds and gender. In contrast, classroom-level differentiation focuses on modifying elements such as content, process, product, and the learning environment. This distinction emphasises the multifaceted nature of differentiated instruction (DI), illustrating its capacity to address both structural and pedagogical dimensions of learner diversity. On the subject level, teachers adjust their instruction to match the needs of their students. This can include making content more difficult or simpler for pupils based on their abilities. The learning process itself can be differentiated.

This may include movies, graphic organisers, photo slideshows, written work, and oral presentations. All of these occur in a secure learning atmosphere where learners feel respected and valued. Significant research has established the efficacy of product-based differentiated instruction at the elementary and secondary levels, but in certain cases, its application in higher education has also been proven to be successful (Connor, 2020).

Ismajli and Imami-Morina (2018) argue that implementing differentiated instruction is critical to meet the unique requirements of pupils. Recognising the importance of adapting instructional methods to meet student needs, teachers must emphasise the implementation of differentiated instruction to successfully help students in reaching their learning objectives (Taylor, 2015). To guarantee proper application of instructions,

especially for young learners, more parental supervision is required (smajli & Imami-Morina, 2018). Within this framework, the teacher takes on the role of a guide, providing students with guidance to steer them towards successful learning outcomes.

According to Tomlinson (2021), differentiated learning is an approach to education that considers students' learning profiles, interests, and abilities in addition to their readiness for learning. Differentiated learning can be approached in three ways: content, process, and product (Taylor, 2015). Students can process concepts and information through process differentiation, which considers their individual learning preferences. Product differentiation, in which pupils demonstrate their knowledge. However, compared to process differentiation and learning content, teachers focus more on product differentiation (Ismajli & Imami-Morina, 2018). Teaching and learning activities are still infrequently carried out, even though differentiated learning is not new.

Teachers can create learning modules using differentiated instruction in the independent curriculum (Marliana et al., 2022). This proactive strategy can help to provide a thorough and effective educational experience, meeting varied instructional needs while establishing a friendly and inclusive learning environment.

Differentiated instruction is a teaching strategy that involves tailoring content, processes, products, or learning environments to students' readiness levels, interests, and learning profiles (Tomlinson, 2001). Differentiation refers to adapting training to match individual requirements. An effective approach to teaching is achieved using flexible grouping and continuous assessment, regardless of whether teachers' diversity in their content, methods, products, or learning environment.

2.3.1 Elements of differentiated instruction

2.3.1.1 Content

Differentiated content adaptation extends beyond conventional instructional approaches to ensure relevance, accessibility, and equity for diverse learners. This approach allows educators to adjust the level of difficulty of course materials while incorporating a variety of media to enhance comprehension and engagement (Anderson, 2007; Bender, 2012; Heacox, 2002; Taylor, 2015; Tomlinson, 2014). In adjusting content this way, teachers can address students' varied readiness levels, interests, and learning profiles, thereby fostering more meaningful learning experiences. While differentiated content is effective, challenges remain, particularly in contexts such as language instruction, where limited resources may constrain implementation. To address these challenges, Nguyen and Walker (2023) propose strategies that prioritise technology integration and collaborative learning. Research suggests that digital tools and structured peer interactions can mitigate resource limitations while providing more adaptable and interactive pathways for language learning (Alavinia & Sadeghi, 2013). These reflect the broader shift toward learner-centred, individualised instruction. Using technology and peer collaboration, teachers can overcome practical barriers and ensure that differentiated content remains both accessible and impactful across diverse educational setting.

2.3.1.2 Process

Process refers to the instructional approaches used to help students grasp essential information, concepts, and ideas. It emphasises how learners engage with and carry out learning tasks (Tomlinson, 2014). Within differentiated instruction (DI), the teacher adjusts these processes according to students' readiness levels, interests, and learner

profiles, ensuring that instruction is responsive and meaningful. Recent research emphasises that effective DI requires a combination of strategies, such as scaffolding and the integration of information and communication technologies (ICT), to create personalised learning pathways for students. Equally important is the professional development of teachers, which equips them with the knowledge and skills necessary to implement DI successfully in diverse classrooms. Recent scholarship highlights the importance of adapting teaching methods to meet the evolving demands of contemporary classrooms. Alber and Nelson (2020) emphasise the need for practical strategies that foster inclusivity, ensuring that all learners are meaningfully engaged in the learning process. Complementing this perspective, Tomlinson and Moon (2021) argue that assessment practices must be updated to align with differentiated instruction, thereby providing teachers with tools to address the diverse readiness levels, interests, and learning profiles of students. These studies indicate that effective pedagogy in the 21st century requires both inclusive differentiated instructional strategies and assessment approaches designed to support differentiation. Through integrating traditional frameworks with innovative strategies, teachers can better address the varied needs of learners and promote equitable, effective learning outcomes.

2.3.1.3 Product

In educational contexts, the concept of a product refers to a culminating project that reflects students' learning at the end of an instructional unit. Rather than relying on rote memorisation, effective products require learners to apply knowledge in critical and creative ways, shifting their role from passive recipients of information to active producers of knowledge (Montuoro & Lewis, 2015; Schwab et al., 2020a, 2020b). Such products can be tailored to students' varying readiness levels, interests, and learner profiles, yet they should consistently aim to engage, challenge, and extend students'

thinking. Differentiating products is therefore viewed as essential, as it provides learners with meaningful choices aligned with their learning preferences and needs, thereby fostering engagement, ownership, and personal investment in the learning process. Research further highlights the importance of integrating students' perspectives when designing differentiated products. Johnes (2023) and the National Association of Special Education Teachers [NASSET] (2023) identify strategies such as mind mapping and role-playing as particularly effective in enhancing both engagement and conceptual understanding. To maximise the impact of these approaches, teachers are advised to provide scaffolding and structured support so that all learners, regardless of background or ability, can successfully meet their educational goals (Schwab et al., 2020a, 2020b). These studies reinforce the centrality of differentiated products within differentiated instruction, emphasising their role in promoting equity, ensuring access, and enabling students to demonstrate mastery through diverse and meaningful ways.

2.3.1.4 Learning environment

In differentiated classrooms, both the physical environment and the pedagogical approach are recognised as pivotal in influencing student success. Research underscores that an inviting learning space characterised by thoughtfully arranged furniture, appropriate comfort levels, and well-managed sound, temperature, and lighting can foster a sense of community and responsiveness among learners (Burke & Burke-Samide, 2004). When classrooms are designed to be supportive and inclusive, students are more likely to engage actively, ask questions without fear of judgment, and contribute meaningfully to the shared learning process (de Anda, 2007). The empirical studies further underscore the importance of classroom climate in supporting learning outcomes. Jalaludin and Hashim (2020) found that positive student-teacher interactions,

coupled with a conducive physical environment, are essential in enhancing academic achievement. Similarly, Vargas-Parra et al. (2018) suggest that a well-structured learning environment not only facilitates overall academic performance but also plays a vital role in improving students' language skills. Within the framework of differentiated instruction (DI), the classroom environment also supports autonomy, collaboration, and motivation. By involving students in establishing classroom norms and encouraging them to take part in problem-solving processes, teachers foster ownership of learning while cultivating a positive and engaging atmosphere (Yuen et al., 2023). These practices show how both physical and social aspects of the classroom environment interact with pedagogical strategies to enhance student learning and engagement in differentiated settings.

2.3.2 The Strategies Employed in Differentiated Instruction

2.3.2.1 Flexible Grouping

Flexible grouping is a core strategy within differentiated instruction that enables teachers to organise students into groups based on their abilities, interests, or learning styles for tasks or projects. According to Tomlison (2001), flexible grouping promotes student engagement by allowing learners to work with peers who complement their learning needs. This approach ensures that grouping is dynamic rather than static, allowing students to work with a variety of peers across different learning contexts. Flexible grouping not only addresses individual learning needs but also promotes collaboration, peer learning, and the development of social and academic skills. Through carefully designed groupings, teachers can provide targeted support and extend learning opportunities, ensuring that students benefit from both individualised attention and cooperative experiences. This strategy reinforces the principles of

inclusivity and responsiveness, making it a practical and effective means of fostering student engagement and success in diverse classrooms.

2.3.2.2 Flexible seating

A flexible seating classroom is an innovative learning environment where traditional, fixed seating charts are replaced with adaptable seating arrangements that allow students to choose where they sit. A study by Brooks (2018) found that students in flexible seating environments reported higher levels of satisfaction and motivation. This approach empowers learners by giving them autonomy over their physical learning space, fostering a sense of responsibility and ownership of their education. Flexible seating also accommodates diverse learning preferences, as some students may thrive in quiet, individual spaces while others benefit from collaborative seating arrangements. To provide students with choices regarding where and how they sit, teachers can create a more engaging and student-centred classroom environment. This idea supports differentiated instruction by recognising that physical space plays a crucial role in learning and that flexibility in seating can enhance focus, collaboration, and comfort for a wide range of learners.

2.3.2.3 Work Zones

Students have diverse preferences when it comes to their learning environments. Some learners concentrate and perform better in quiet, individual spaces, while others thrive in collaborative areas where interaction and discussion are encouraged. Research by Kuhlthau et al. (2015), establishing work zones encourages student agency and ownership over their learning process. To address these differing needs, teachers can intentionally design classroom spaces that accommodate both types of learners. Ideally, this involves designating separate areas within the classroom, one that provides a calm,

distraction-free setting for independent work, and another that allows for more active, noise-tolerant collaboration. Such spatial differentiation supports student autonomy by enabling learners to choose environments that align with their needs and tasks. It also reflects the principles of differentiated instruction by recognising that classroom design can significantly impact focus, engagement, and productivity. To offer varied spaces for learning, teachers create inclusive environments that respect student differences and promote both individual and group success.

2.3.2.4 Tiered Activities

Tiered activities are an instructional strategy within differentiated instruction that allows teachers to design tasks at varying levels of complexity to meet the diverse readiness levels of students. Research by Reis et al. (2011) shows that tiered activities can lead to improve student performance and engagement by allowing learners to work at their own pace. This approach ensures that all learners engage with the same core content but at a level that is appropriately challenging for them. Students may begin with foundational activities and gradually progress to more advanced tasks, thereby supporting both skill development and deeper conceptual understanding. The effectiveness of tiered activities lies in their adaptability. In the same classroom, students may be given different versions of a single activity, tailored to their readiness levels, learning profiles, or interests. This not only promotes equitable access to learning but also prevents students from feeling either overwhelmed or underchallenged. Through scaffolding learning, tiered activities foster student confidence, motivation, and mastery of essential concepts.

2.3.2.5 Demonstration

Demonstration is an instructional strategy that allows teachers to model concepts, skills, or processes for students, providing a clear example of what is expected. Demonstrations can effectively convey complex ideas and provide clear examples for students to follow (Rosenshine, 2012). Through this approach, learners observe how a task is performed before attempting it themselves, which helps bridge the gap between theory and practice. Demonstrations are particularly effective in making abstract ideas more concrete and accessible, especially for visual and kinaesthetic learners.

In the context of differentiated instruction, demonstrations can be adapted to meet varied readiness levels and learning styles. Most students may benefit from step-by-step demonstrations with detailed explanations, while others may thrive when allowed to observe a complete process before practising independently. Demonstrations also support scaffolding, as teachers can gradually release responsibility by first modelling the skill, then guiding students through practice, and finally encouraging independent application.

2.3.2.6 Hands-on Activities

Hands-on activities are instructional strategies that actively engage students in the learning process by allowing them to manipulate materials, conduct experiments, build models, or participate in simulations. Research indicates that hands-on activities enhance student engagement and deepen understanding (Prince, 2004). This experiential approach helps bridge theory and practice, enabling learners to construct knowledge through direct interaction with concepts and ideas. This flexibility ensures that all students are challenged appropriately while accessing the same core content.

Hands-on activities encourage collaboration and communication, as students often work in pairs or groups to complete tasks. They also encourage critical thinking, creativity, and problem-solving, aligning with the principles of student-centred and inquiry-based learning. To provide opportunities for active participation, hands-on activities promote deeper engagement, build learner confidence, and support diverse pathways to mastery.

2.3.2.7 Group Discussion

Group discussion is an instructional strategy that encourages students to share ideas, exchange perspectives, and collaboratively construct knowledge through dialogue. Through conversation, learners can be able to deepen their understanding of concepts, clarify misconceptions, and develop critical thinking and communication skills. Group discussions provide opportunities for students to practice respectful listening, negotiation, and argumentation, which are essential for collaborative learning environments (Dawson & Hargreaves, 2015). In the context of differentiated instruction, group discussions can be tailored to accommodate diverse readiness levels, interests, and learning profiles. Teachers can organise heterogeneous groups that allow stronger students to support peers, or they can form groups around shared interests or similar ability levels to ensure that discussions remain meaningful for all participants. Through the DI approach, group discussions foster active engagement and a sense of belonging, allowing students to learn from one another while also contributing their own unique ideas. As such, group discussions not only strengthen academic understanding but also promote inclusivity, collaboration, and social development within differentiated classrooms.

2.3.2.8 Learning Centres

Learning centres are an instructional strategy that provides students with opportunities to explore various aspects of a topic through hands-on activities and resources designed to address diverse learning styles. These centres support differentiated instruction by allowing students to choose tasks that aligns with their interests and readiness levels (Baker et al., 2017). Rotating through different centres, students can engage with content in multiple ways, whether through reading, problem-solving, experimentation, or creative expression, ensuring that instruction caters to varied strengths and preferences. This approach not only accommodates learner diversity but also fosters independence and self-directed learning. Within learning centres, students are encouraged to take responsibility for their own progress, make choices about their learning pathways, and engage actively with the material. As a result, learning centres promote autonomy, critical thinking, and engagement, while reinforcing the principles of differentiated instruction by providing multiple avenues for students to access, process, and demonstrate understanding of content.

2.3.3 Assessment

Differentiated instruction (DI) is a proactive, student-centred approach designed to meet the diverse needs of learners within inclusive and heterogeneous classrooms. Central to DI is the use of ongoing assessment, which guides instructional decisions and ensures that teaching remains responsive to student needs. Recent research highlights differentiated assessment as a crucial element in personalising learning, as it fosters student engagement, achievement, and overall academic success (Moallemi, 2023; Pozas & Schneider, 2019). Central to this perspective is the strong link between assessment and instruction, where well-designed assessment systems not only measure progress but also provide timely, specific feedback that guides instructional decisions

and necessary learning adjustments (van Geel et al., 2019). The studies emphasize that effective assessment practices are integral to responsive teaching and the advancement of differentiated instruction.

Classroom assessments are typically categorised into pre-assessment, formative assessment, and summative assessment. Pre-assessments enable teachers to identify students' readiness levels, interests, and learning profiles before instruction, allowing them to design lessons that are more effectively aligned with student needs (Turner et al., 2017). Formative assessments take place during instruction and are used to monitor progress, enabling teachers to adjust the pace, methods, and content delivery to support individual learners (Shareefa et al., 2019). Summative assessments, conducted at the end of an instructional unit, evaluate the overall effectiveness of teaching and student learning. Importantly, results from summative assessments can also serve as pre-assessment data for subsequent units, thereby creating a cyclical process of instructional refinement (Moallemi, 2023).

Beyond its impact on academic outcomes, differentiated instruction (DI) plays a vital role in supporting students' social and emotional development. Studies demonstrate that DI enhances student well-being, promotes social inclusion, and strengthens academic self-concept, thereby extending its influence on the overall quality of education (Alnahdi et al., 2021; Schwab et al., 2020a, 2020b). The studies emphasise the value of DI practices that are responsive to students' readiness, interests, and individual needs, ensuring equitable opportunities for all learners to succeed and thrive within inclusive classroom environments.

2.4 The Use of Differentiated Instruction by Teachers

The use of differentiated instruction (DI) has been shown to positively influence student performance by enhancing commitment, interest, and satisfaction (Johnsen, 2003), as well as improving learners' self-confidence (McQuarrie et al., 2010). Students taught through DI often demonstrate increased motivation (McAdamis, 2001), and their academic potential can be more fully realised when instruction is tailored to their diverse needs (Wilujeng, 2012).

At its core, DI is an instructional theory and practice that enables teachers to plan strategically to meet the needs of all students in a single classroom. Differentiated instruction involves the use of multiple teaching approaches designed to accommodate the diverse aptitudes, interests, personalities, and prior learning experiences of students (Mulder, 2014). The differentiated instruction is learner-oriented, inquiry-driven, activity-intensive, and frequently designed around student interests (Chamberlin & Power, 2010; Smit & Humpert, 2012; Tomlinson, 2001). When classrooms are viewed as communities of learners with different readiness levels, abilities, and interests, it becomes evident that teachers who do not differentiate instruction risk reaching only a portion of their students (Chamberlin & Power, 2010; Koeze, 2007). In contrast, differentiated instruction ensures that instruction is inclusive and equitable, allowing educators to address the needs of students at varying skill levels simultaneously (Smit & Humpert, 2012; Tomlinson & Imbeau, 2010).

Research further suggests that differentiation provides opportunities for teachers to craft lessons that connect with multiple student interests, leading to improved learner engagement and stronger academic outcomes (Fitzgerald, 2016; Lauria, 2010). Achieving effective differentiation requires teachers to carefully observe and understand the individual differences among their students and to use this knowledge

as a basis for instructional planning. Research consistently underscores that responsiveness to learner diversity is central to tailoring instruction in ways that meet varied needs and promote equitable learning opportunities (Koeze, 2007; Landrum & McDuffie, 2010; Onyishi, 2017; Thakur, 2014; Walton, 2017).

Differentiation is best conceptualised as a comprehensive instructional approach that offers students multiple pathways for engagement. It provides learners with choices concerning the content they study, the processes through which they acquire knowledge, and how they demonstrate understanding. This flexibility positions differentiation as a holistic strategy for addressing learner diversity and promoting meaningful participation in the educational experience. The teachers are expected to address the diversity of learners by differentiating across the four core elements of instruction: content, process, product, and learning environment. In doing so, they can accommodate a wide range of challenges, abilities, and strengths, ensuring that all learners will gain access to meaningful and effective learning opportunities (Abdullah et al., 2014; Chamberlin & Power, 2010; Thakur, 2014). According to Hall et al. (2004), confidence in one's ability to differentiate instruction is a key determinant in whether teachers adopt and sustain such strategies. When teachers believe they can effectively meet students' varied needs, they are more likely to invest the effort and creativity required for differentiation.

2.5 Impact of Differentiated Instruction on Students' Academic Performance in Science

Differentiated instruction (DI) is widely recognised as a vital pedagogical approach for sustaining learner engagement while responding to the diverse needs of students. At its core, DI requires acknowledging and utilising learners' individual strengths, weaknesses, and preferences to view the classroom both as a collective learning

community and as a space where each student's unique profile is valued (Hall, 2002; Zerai et al., 2021). In practice, this often translates into designing group activities that draw upon common backgrounds or shared experiences, a strategy particularly useful in larger classrooms where the variation among learners can be significant. Such practices not only promote inclusivity but also allow educators to implement effective differentiation at scale.

Previous research supports the notion that DI is a comprehensive framework for responding to the varied needs of learners in diverse classroom contexts (Karadag & Yasar, 2010; Logan, 2011; Magableh & Abdullah, 2020; Servilio, 2009; Subban, 2006; Tulbure, 2011). A key element of this framework is the expectation that teachers first develop a clear understanding of students' readiness levels, abilities, and learning needs. Establishing this foundation enables educators to design instruction that is responsive, targeted, and supportive of diverse learners (Tomlinson, 2014; Tomlinson & Imbeau, 2010). This showed that educators are better positioned to design instructional experiences that align with individual learner profiles while still fostering a sense of collective classroom community.

A study by Subban (2006) found that differentiated instruction positively affected students' engagement and motivation, leading to enhanced academic performance in science classes. Similarly, Tomlinson and Moon (2021) reported that students in classrooms utilising differentiated strategies showed significant gains in achievement compared to those in traditional settings.

Studies have consistently demonstrated that differentiated instruction (DI) enhances student learning outcomes. Research by Garba (2015) and Kreitzer (2016) found that DI significantly improves students' academic achievement by aligning instructional

strategies with learners' diverse needs. Beyond academic performance, DI also plays a critical role in engaging students, stimulating their interests, and providing meaningful and gratifying learning experiences (Wiselby, 2014). A key principle underpinning DI is the recognition that children learn most effectively when instruction aligns with their preferred learning styles. However, despite evidence supporting this approach, some teachers continue to overlook students' individual preferences, limiting opportunities for learners to engage with content in ways that best suit their needs (Smit & Humpert, 2012). Ignoring this underscores the importance of teacher awareness, training, and willingness to embrace differentiated practices as a means of supporting equitable and effective learning.

2.6 Challenges in the Implementation of DI by Teachers

Research underscores the pivotal role of professional training in the successful implementation of differentiated instruction (DI). Dixon, Yssel, McConnell, and Hardin (2014) found that professional development not only strengthens teachers' self-efficacy but also enhances their effectiveness in applying DI strategies in the classroom. Access to sustained and targeted training enables teachers to develop the skills and confidence necessary to adapt instruction, manage diverse learning needs, and design inclusive classroom environments. In this way, professional training serves as both a catalyst for improving teacher practice and a mechanism for fostering positive student outcomes within differentiated classrooms. The study considered variables such as school type, teaching experience, and the number of professional development sessions attended. Findings revealed a positive and proportional relationship between teachers' qualifications and their effectiveness in implementing DI, suggesting that ongoing professional training is essential for equipping educators with the skills necessary to meet diverse student needs. Complementary insights are provided by Roiha (2014) in a

study exploring teachers' perspectives on differentiation within Content and Language Integrated Learning (CLIL). The findings reveal that while teachers recognise the value of differentiation in supporting diverse learners, they often face challenges in balancing content mastery with language development. Roiha's work highlights both the promise and the practical difficulties of implementing differentiation in CLIL contexts, emphasising the need for clearer pedagogical strategies and stronger institutional support to enable teachers to meet varied learner needs effectively. Conducted in Finland, this research examined how teachers perceive the integration of diverse content and language in CLIL classrooms, with a particular focus on supporting students with special needs. The results indicated that while teachers acknowledged the value of DI, significant challenges persisted, particularly concerning limited time, insufficient materials, and classroom environment constraints. Thus, these studies emphasise both the impact and the challenges of implementing DI. The studies highlight the importance of teacher preparedness, adequate resources, and supportive environments in ensuring that differentiation can be effectively practised in diverse educational contexts. Research identifies teacher self-efficacy as a critical predictor of instructional practice, classroom management, and student achievement. High levels of self-efficacy are associated with more adaptive teaching behaviours, greater persistence in addressing challenges, and improved learning outcomes (Tschannen-Moran & Woolfolk Hoy, 2001). Within the context of differentiated instruction, teacher self-efficacy is particularly important, as confidence in one's instructional abilities directly influences the willingness to implement flexible strategies, adapt lessons to diverse learner needs, and create inclusive classroom environments. The teachers with high self-efficacy are more willing to adopt innovative methods, such as differentiated instruction, inclusive practices, and inquiry-based learning.

Despite the benefits, implementing differentiated instruction presents challenges for teachers. Research by Gentry and Springer (2002) highlights issues such as large class sizes, lack of resources, and insufficient training as barriers to effective differentiation. These challenges can hinder teachers' ability to tailor instruction adequately and may limit the potential benefits for students. Teachers' perspectives reveal a strong appreciation for the principles of differentiated instruction (DI), while also underscoring the significant challenges associated with its implementation. Several studies have identified common barriers that hinder the effective implementation of differentiated instruction. These include the considerable time and effort required for lesson planning, rigid curriculum frameworks, limited access to professional development, large class sizes, and the lack of diverse instructional resources (Magableh & Abdullah, 2020; De Bruin, 2018; Joseph et al., 2013; Santangelo & Tomlinson, 2009). These challenges suggest that while DI is widely valued as a pedagogical approach, its application often demands more resources and support than many educational systems currently provide.

More recent research further explores these obstacles, identifying additional factors that hinder effective DI implementation. These include rapid technological changes, sociocultural expectations, and entrenched teacher-centred approaches that limit flexibility in teaching practices (Heng & Song, 2020a, 2020b; Zerai et al., 2021). Teachers also face difficulties linked to student-related challenges, such as varying personal circumstances, as well as feelings of professional helplessness and administrative hurdles within schools. These findings indicate the complex interplay between structural, institutional, and personal factors that influence the successful implementation of DI. Addressing these challenges requires systemic support, targeted

professional development, and collaborative efforts to create environments where teachers can practice differentiation effectively and sustainably.

Research indicated that inadequate resources often hinder the effective implementation of differentiated instruction. Teachers may lack access to essential instructional materials, appropriate technologies, and ongoing professional development opportunities, all of which are crucial for supporting diverse learners (Zerai et al., 2023). Without these resources, teachers may struggle to adapt instruction to meet the varying needs of students effectively. Studies by Smets and Struyven (2020) reveal that teachers often face difficulties balancing the time required to design, prepare, and implement differentiated strategies while simultaneously covering the mandated curriculum. This challenge is particularly pronounced in classrooms with large numbers of students or where curriculum pacing is rigidly prescribed. Thus, these findings reveal the importance of providing teachers with sufficient resources, technological support, and professional development, alongside manageable time structures, to facilitate the sustainable and effective practice of differentiated instruction.

Despite the barriers to implementation, research indicates that teachers can adopt proactive strategies to make differentiated instruction both effective and engaging. Jufrianto et al. (2023) emphasize that enrichment-oriented practices enable educators to respond more flexibly to learner diversity. A widely used strategy is flexible grouping, where students are organized according to readiness levels, interests, or learning profiles, allowing teachers to tailor activities that meet specific needs (Suprayogi et al., 2018). This approach not only supports targeted instruction but also connects directly to the core dimensions of differentiation content, process, and product by enabling educators to adjust what students learn, how they engage with material, and how they demonstrate understanding. As such, flexible grouping represents a practical

mechanism for operationalizing DI in ways that enhance inclusivity and promote meaningful learning outcomes.

2.7 Students' Attitudes towards Differentiated Instruction

Students' attitudes towards differentiated instruction play a crucial role in its effectiveness. Research suggests that when students perceive their learning environment as supportive and responsive to their needs, they are more likely to engage positively with the material (McCoy, 2010).

Studies by McCoy (2010) indicate that students who experience differentiated instruction report higher levels of motivation and satisfaction with their learning experiences. They appreciate having choices and opportunities to work at their own pace, which contributes to a sense of autonomy in their education.

2.8 Conceptual Framework

The conceptual framework serves as a visual representation of the key components and relationships that underpin the study of differentiated instruction and its impact on academic performance in Integrated Science. This framework will guide research design, data collection, and analysis, providing a structured approach to understanding how differentiated instruction influences student outcomes.

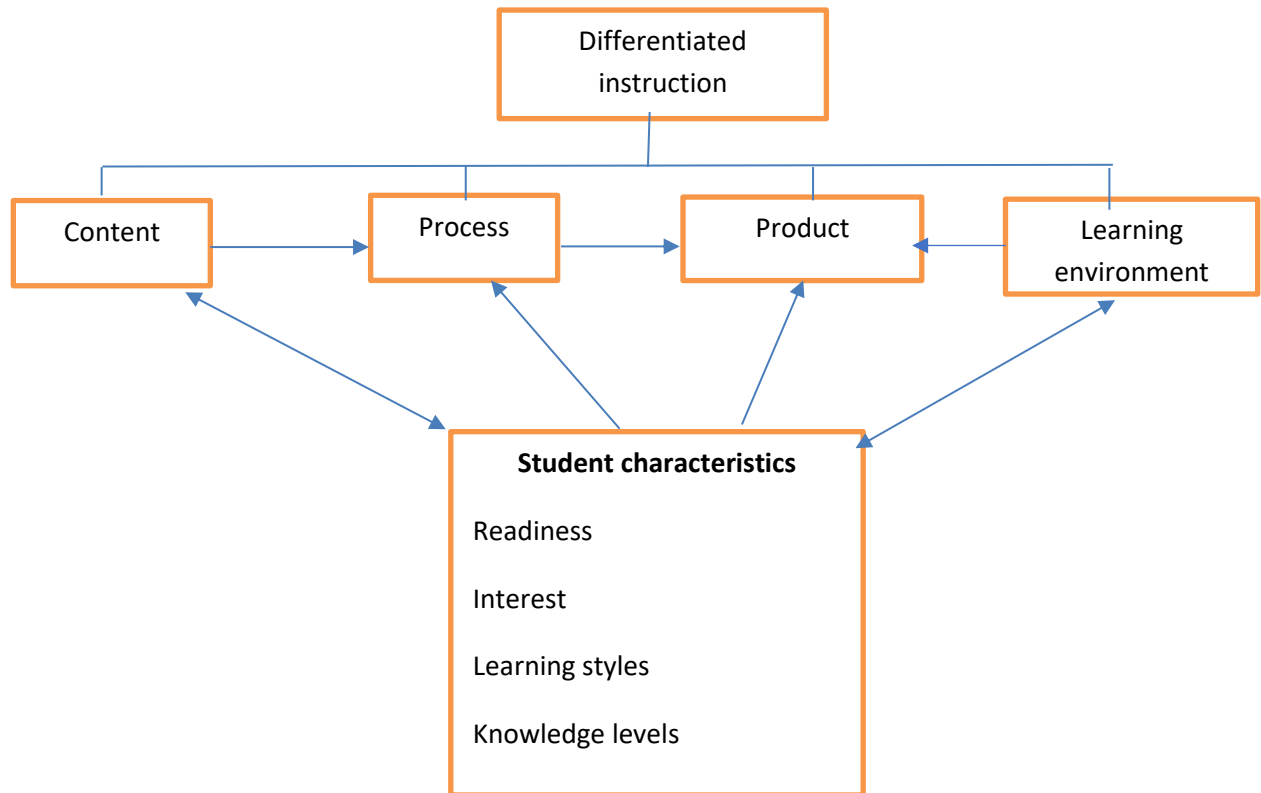


Figure 1: *Conceptual framework of the study*

2.9.1 Components of the conceptual framework

The conceptual framework of differentiated instruction is made up of five components. These include.

2.9.1.1 Key Principles

Acknowledging student diversity, meeting individual needs, and maximising learning proactive approach is the key principle of DI in the classroom

2.9.1.2 Elements of Differentiated Instruction

Elements of differentiated instruction include content, process, product, and learning environment.

2.9.1.3 Student Characteristics

The students' characteristics cover their readiness to learn or understanding levels, learning styles, and interests as well.

2.9.1.4 Operational Nature of Differentiated Instruction

The operational nature of differentiated instruction includes assessment, planning, implementation, monitoring, and adjustment

2.9.1.5 Effects of Differentiated Instruction

The potential effects of using DI in the Integrated Science class include increased learner engagement, improved learning outcomes, enhanced self-efficacy, and teacher flexibility

2.9.1.6 Differentiated Instruction Strategies

DI strategies used in lesson delivery consist of: Flexible grouping, Tiered assignments, Learning centres, Hands-on activity/Experiment, Demonstrations, Group discussions (Whole class/ Small class discussion), and Assessments (Presentation, Group work, Class test, Report work, Project, Oral questions and answers)

2.9.2 Relationships among components

The conceptual framework integrates key theoretical constructs and variables to examine the relationship between differentiated instruction (DI) and students' academic performance. In this study, DI is employed as an instructional approach to enhance students' understanding and achievement in the Selected Concepts of Integrated Science. The independent variable is the differentiated instruction approach, while the

dependent variable is students' academic performance in the identified concepts. Academic performance will be measured using test-based assessments.

The conceptual framework considers mediating variables that may influence the relationship between DI and academic performance. Those variables link the dependent variable to the independent variable. They include students' interest, motivation, engagement, and learning outcomes. Thus, when DI is used to teach students, it improves their interest and motivation to participate fully in class. Students' improved interest and motivation enable them to pay maximum attention to whatever is taught in class for conceptual understanding.

2.7.4 Implications for the study

This conceptual framework will guide the research process by providing a clear structure for exploring the relationship between differentiated instruction and academic performance in Integrated Science. It will inform the selection of research methods, data collection instruments, and analysis techniques, allowing for a comprehensive examination of how differentiated instruction can enhance student learning outcomes.

2.7.5 Conclusion

This literature review highlights the theoretical foundations of differentiated instruction and its potential impact on academic performance in Integrated Science education. While research supports the effectiveness of differentiated strategies in enhancing student engagement and achievement, challenges remain in their implementation within traditional educational settings. Furthermore, students' attitudes towards differentiated instruction significantly influence their success, underscoring the need for educators to foster a supportive learning environment.

The findings derived from this literature review will guide the design and implementation of the study, which examines the effect of differentiated instruction on the academic performance of Integrated Science students at Paga Senior High School and Nabango Senior High Technical School. The conceptual framework further illustrates the relationship between differentiated instruction and its core components, providing a foundation for the investigation.



CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter discusses the methods and procedures that were used by the researcher in conducting the study. These include Research design, Population, sampling technique, Data collection instruments, Data collection procedure, Data analysis technique, and Ethical considerations.

3.1 Research Approach and Design

The research approach adopted for this study is a mixed-method approach. Mixed methods is a research approach which integrates both qualitative and quantitative strategies within a single investigation or series of studies. Mixed methodology focuses on the collection, analysis, and integration of numerical data with descriptive insights, thereby offering a more comprehensive exploration of the research problem. According to Creswell and Clark (2017), combining qualitative and quantitative approaches provides a deeper and more nuanced understanding of complex issues than relying on either method alone. In this study, data were collected and analysed using both qualitative and quantitative instruments. This integration reflects the principle of triangulation, which is widely regarded as one of the most effective strategies for ensuring rigour in research (Donkoh & Mensah, 2023). Triangulation involves identifying convergence or confirmation across multiple data sources, instruments, researchers, and methods. Bayat (2007) notes that triangulation allows researchers to compare and validate findings across different perspectives, while Willis et al. (2007) emphasise its role in confirming data consistency across various collection techniques. The central idea is that the limitations of one method are often counterbalanced by the

strengths of another, thereby enhancing the validity and reliability of findings. Thus, that is why the researcher used this mixed-method approach for the investigation.

Predicting all components of the research and planning for them to occur in a coordinated manner can be achieved by the design of the study (Blaikie, 2000). Good research designs incorporate some flexibility, which is generally achieved by the repetition of fundamental design features (Akhtar, 2016).

The study employed a quasi-experimental design. The quasi-experimental research design is comparable to an experimental design in its purpose and structure but differs in the level of control it affords the researcher. Unlike a true experimental design, which requires random assignment of participants to experimental and control groups, quasi-experimental research does not allow for full randomisation due to ethical, logistical, or practical constraints. Instead, participants are assigned to groups through self-selection, pre-existing conditions, or researcher placement. Despite this limitation, quasi-experimental designs are widely used to assess the impact of interventions and to establish potential cause-and-effect relationships between independent and dependent variables. The strength of quasi-experimental design lies in its ability to balance practical feasibility with scientific rigour. While the lack of randomisation can introduce bias and reduce internal validity, the design compensates by offering external validity, as it reflects natural learning environments and real classroom dynamics. Researchers often employ additional strategies such as matching groups, statistical controls, or pre- and post-tests to minimise potential threats to validity.

Thus, this research design requires that the researcher gather data and analyse it in accordance with the purpose, objectives, and questions. This study design will yield clear, reliable, valid, and useful findings for the researcher. The design enables a

comparison of academic achievement between students taught with differentiated instruction and those taught using traditional methods. The study included two groups: experimental and control. The experimental group received differentiated instruction, whereas the control group received traditional training without a differentiated strategy.

3.2 Research Population

A population is a particular group of people having common features (Creswell, 2012). Furthermore, Anhwere (2013) defines a population as the total collection of research groups that meet a specific set of characteristics. This implies that, regardless of the fundamental unit, the population always represents the whole aggregation of components in which the researcher is interested. The study was conducted at both Paga SHS and Nabango SHTS in the Kasena-Nankana West District. Paga Senior High has 535 students, whilst Nabango Senior High Technical has 385. The combined staff is 123. The total student population is nine hundred and twenty (920), comprising 408 boys and 512 girls. The target population consisted of 350 students enrolled in general art courses. The accessible population included second-year general art students from both SHSs. The researcher chose general art students because they are non-science students whose subject areas have no direct relation with concepts in science, so they are likely to appreciate the use of differentiated instruction in learning the 'Selected Concepts' in Integrated Science.

3.3 Sample and Sampling Technique

According to Jackson (2008), surveying an entire population relevant to a study is often impractical and unnecessary. Consequently, researchers select a sample, which serves as a smaller, representative subset of the population. For your conclusions to be

meaningful, accurate, and valid, the sample must closely reflect the characteristics of the research population in other words, it must be a representative sample.

According to Creswell (2012), a sample is a subset of the target population that the researcher selects to examine specific characteristics and draw generalisations about the larger population. To learn more about the actual condition and traits of the population, a sample is taken. In a research project, sampling is the process of choosing a subset of the population of interest (Turner, 2020). According to Pickard (2007), the sampling strategy employed is crucial to any research study since, frequently, the scale, makeup, and features of the sample provide significance to any conclusions drawn from it. Therefore, depending on the goals and problem of the study, several sampling procedures are used in empirical research.

The purposive sampling technique was used to choose the sample population. Purposive sampling was chosen because it allowed the researcher to carefully select a group of students who shared characteristics and requirements that were interesting to the researcher and relevant to the research study. These groups of students are not science students and who probably value differentiated instruction in improving their performance on the selected concepts in Integrated Science. The sample population consisted of 44 students: 18 were males and 26 were females. Two intact groups were utilised because they had already been formed in the schools due to accessibility. In a simple random manner, researcher selected one class from each school forms a group.

The researcher designated one class from Paga SHS as the Experimental Group (Group A), and the other from Nabango SHTS as the Control Group (Group B). The Experiment Group comprised 29 students: 12 males and 17 females. In addition, the

Control Group consisted of 15 students, six of whom were male and nine of whom were female.

3.4 Data Collection Instruments

The data collection instruments for the study included tests, interviews, and questionnaires. The questionnaire was designed to obtain data from students about their experiences with differentiated instructional strategies used in teaching and learning.

3.4.1 Interview

Kumar (2011) defines content analysis as an examination of the information contained in observational notes or interviews to determine the main themes that emerge from the researcher's observational notes or responses provided by the participants.

Unstructured interviews were conducted one-on-one with a few students to gain deeper insights into students' attitudes toward DI. These interviews allowed participants to freely express their views, concerns, and experiences with differentiated strategies, thereby complementing the survey data with richer, qualitative accounts. The unstructured oral interview conducted, involving 10 respondents who were assigned number codes during the interview section. Students' responses were documented and subsequently analysed into themes. Thematic analysis was carried out in line with Braun and Clarke's (2006) framework. The unstructured interview served as triangulated data to the credibility of the findings obtained concerning students' attitudes toward differentiated instruction.

Due to the nature of the research objectives, topic, and purpose of the research, this type of interview technique was employed. Interview guide indicated in the appendix E.

3.4.2 Tests

The researcher designed a test based on the selected concepts: Corrosion and rusting of metals, Force and Germination of seeds. The test consists of thirty (30) multiple-choice questions and was administered in two stages, namely: pre-treatment test (pre-test) and post-treatment test (post-test). The test was scored over thirty (30). Each item is scored with a value of one mark. Test items shown in the appendix A and C.

3.4.3 Questionnaire

According to Pickard (2007), questionnaires are self-completed instruments that are very simple to use, affordable, and frequently the most feasible alternative for evaluating unobservable structures, including attitudes, values, and preferences, intentions, and personalities.

The questionnaire was rated using a five-point Likert scale. The researcher employed a Likert scale to determine students' perspectives on the various instructional strategies used in teaching and learning integrated science concepts. To design the items, the researcher employed both open-ended and closed-ended questionnaires. The quantitative data from the questionnaires were analysed using descriptive statistics, specifically frequencies and percentages, to summarise students' overall responses and identify patterns in their attitudes. The qualitative data, on the other hand, were analysed using thematic analysis, which provided a systematic approach to identifying, organising, and interpreting recurring themes. The thematic analysis followed the widely recognised six-phase framework outlined by Braun and Clarke (2006), ensuring rigour and credibility in the interpretation of the qualitative findings. Thus, these methods allowed the researcher to triangulate results, thereby strengthening the validity of the findings on students' attitudes toward differentiated instruction in Integrated Science concepts. The researcher personally administered questionnaires to students

and supervised them as they filled them out. The instructions for filling out the questionnaires were clearly stated so that there was no uncertainty. A total of 29 responses were collected from the experiment group. A total of 15 responses were collected and presented as well. Questionnaire items found in the appendix F and G.

3.5 Validity and Reliability of the Research Instrument

According to Bajpai (2014), validity and reliability are psychometric qualities of measuring scales that are crucial for determining the adequacy and precision of scientific research adequacy and precision. Validity simply means that the stated purpose is accurate. While dependability relates to the consistency of results, it specifies whether a test measures what it is intended to measure. The study's validity and reliability issues were important since the validity of the findings, the techniques used to acquire the data, and the dependability of the data all affect how credible the research work is.

3.5.1 Validity of the Instruments

The validity of a study refers to the degree to which it accurately measures what it is intended to measure. Validity can be categorised into several types, including internal validity, external validity, and construct validity (Trochim, 2006). Internal validity pertains to the extent to which the observed results can be confidently attributed to the experimental interventions rather than to confounding variables or other extraneous factors. External validity concerns the generalizability of the study's findings, specifically, whether the results can be applied to other populations, settings, or times beyond the scope of the original research. Construct validity involves the degree to which the instruments or procedures used in the study accurately represent the theoretical constructs they are intended to measure. Each type of validity plays a crucial role in ensuring that the research is methodologically sound and its findings are

meaningful and credible. Validity is defined as "the degree to which a measure appropriately represents the underlying construct that it is supposed to measure" (Drost, 2011). The skill, knowledge, quality, or attitude that the researcher is examining is referred to as the construct. Face validity ascertains that the measure appeared to be assessing the intended construct under the investigation.

According to Zohrabi (2013), validity is trying to explain the truth of research findings, and it is measured using both theoretical and empirical evidence. Drost (2011) explains that content validity is a qualitative form of validity in which the domain of a concept is clearly defined, and the researcher evaluates whether the chosen measures adequately and comprehensively represent that domain. It is mostly employed to evaluate the validity of surveys and questionnaires (Kennedy, 2022). The researcher needs to develop a research instrument that will adequately address the construct or area under investigation.

Validity simply refers to the accuracy of the intended purpose. It describes whether a test measures what it's supposed to measure. The validity indicates how well an instrument measures what it is intended to measure. It ensures that research outcomes are accurate and meaningful.

The content validity of an instrument is concerned with how closely the instrument's content corresponds to the concepts it was designed to measure (Creswell, 2012). Rating items are used to determine the degree of convergence using the Content Validity Index (CVI) formula (Wilson, 2012). Thus, the tests and items were rated with coefficients of a content validity index of 0.85 and 0.89, indicating appropriate data to support the study.

To ensure that the test was valid, copies were given to the integrated science teachers, heads of science departments from the schools, to scrutinise the items to make them ambiguity-free. An interview schedule (unstructured) and questionnaire were also given to the researcher's supervisor, ensuring bias-free data collection. The supervisor of the researcher had verified the validity based on content and face.

3.5.2 Reliability of the Instruments

Drost (2011) defines reliability as "the degree to which assessments can be repeated by different individuals on different occasions, in different conditions, supposedly using different instruments which measure the construct or skill." It can also mean the degree of consistency or reliability of a construct's measure. The degree to which a measurement is consistent and steady when made repeatedly under the same circumstances is known as reliability (Yayra, 2017).

According to Gorman and Clayton (2005), a pilot study involves the preliminary implementation of the draft research plan either in a neutral setting that is not intended for actual fieldwork or within the intended research environment to gather initial data. The purpose of a pilot study is to test the feasibility, clarity, and effectiveness of the research instruments and procedures before the main study is conducted. This process allows researchers to identify and address potential challenges, refine their methodology, and enhance the reliability and validity of the final data collection process.

Reliability refers to the consistency and stability of a measurement across different occasions, items, and evaluators. A reliable instrument consistently yields the same results when administered under similar conditions, demonstrating dependability in its measurements. High reliability is fundamental for ensuring that research findings are replicable and trustworthy, thereby increasing confidence in the study's outcomes. In

minimising measurement errors, reliability enhances the general quality, credibility, and validity of the research, ultimately contributing to more robust and meaningful conclusions. Reliability was determined for its internal consistency using Cronbach's alpha. Cronbach's Alpha indicates how items are related and measure the same underlying concept. Test-retest reliability is a vital measure for determining the consistency of a test or measurement tool over time. Data from the pilot test were used to determine the reliability of the instruments. The pilot testing was done on a few samples of students who were not part of the study. To ensure there was no ambiguity, the researcher employed pilot testing to find and fix any problems with the test and questionnaire items. Thus, suggestions offered were used for the improvement of the instruments.

In the pilot testing for reliability, test-retest reliability coefficient was 0.77, indicating that the test is considered reliable, as the scores show strong consistency over time. The Cronbach's alpha coefficient for questionnaires was 0.80, considered significantly reliable for the research study. These coefficient values clearly indicate that the reliability is higher in both tests and the questionnaire.

3.6. Data Collection Procedure

In a research project, the process of gathering data is essential to guarantee that the information gathered is accurate, trustworthy, and pertinent to the research questions (Creswell 2014). Pre-test, treatment (intervention), post-test, interview and questionnaire delivery were the five steps in the data collection process. Before and after treatment, the same pre-test and post-test were administered to every student in the experimental group and the control group. Following the treatments, only the experimental group was administered the interview and questionnaire. Eight (8) weeks were allotted for conducting the study.

3.6.1 Pre-Treatment

Through interaction, the researcher asked students to know their prior knowledge concerning the selected concepts and any instructional strategies used. The researcher then administered the self-constructed tests to the students in both experimental and control groups in their respective classrooms. Multiple-choice test containing 30 questions with a duration of 60 minutes. The pre-test was conducted by the researcher to assess students' understanding of the selected concepts in Integrated Science before the treatment.

3.8 Treatment Processes

Treatment refers to the specific action or approach given to a participant in a study or experiment to improve a particular condition or outcome. Treatment is often a type of intervention that includes strategies used in the study.

The researcher used a series of differentiated strategies with varied instructional materials as part of the treatment to determine their effectiveness on the students' outcomes. The researcher was comparing the traditional method (Teacher-centred) with less instructional materials to the advanced method called differentiated instruction, which is more Student-centred, and which includes varied teaching strategies with instructional materials during teaching and learning activities. The treatment used by the researcher focused mainly on the effectiveness of differentiated instruction on students' performance in integrated science lessons delivered based on the selected topics. The selected concepts included corrosion and rusting of metals, force and seed germination. The researcher used six weeks to present three separate lessons on different occasions. The designed instructional time for the session was two hours per week for both groups.

3.8.1 Students in the Control Group (Group B) Taught Using Traditional

Approach

The students in Group B were instructed using with traditional method by the researcher. The researcher basically used the lecture method without varied instructional strategies to deliver his lessons on the concept. The researcher based his lessons on corrosion and rusting of metals. The summary of the lesson was written as core points while students copied them on the marker board.

On different occasions, through lecture methods, students were instructed concept of force by the researcher without using any differentiated instructional approach. Also, the summary of the lesson was written on the board as core points for the students to copy.

Again, the researcher traditionally taught the students germination of seeds in plants. The researcher then identified the key points on the board for his students to write.

3.8.2 Differentiated Instruction Used to Teach Students in the Experimental Group (Group A)

Students in Group A were taught using an interactive and engaging student-centred approach, which includes differentiated instructional strategies and respective teaching materials. The varied strategies used by the researcher included small group discussions, whole class discussions, demonstration, practical experiment /hands-on activities, assessments (group assignment, group presentations, report, oral questions and answers), flexible grouping, tiered activities, and flexible seating.

3.8.2.1 Plan for Lessons Presentations

LESSON 1

TOPIC: Corrosion and Rusting of Metals

Relevant Previous Knowledge (RPK): Students have been seeing rusted objects in their environment (Homes).

Objectives: By the end of the lesson, students will be able to:

- 1) Explain corrosion and rust
- 2) Identify the conditions necessary for the rusting of iron through an experiment
- 3) State the effects of corrosion and rusting on metals
- 4) Describe ways of preventing corrosion and rusting of metal

Differentiated Instruction Strategies:

Flexible seating, Whole class discussions, Demonstrations, Hands-on experiments and Small-group discussions, Assessments (class discussions, report, oral questions and answers)

Instructional Resources:

Chart showing the rusting process

Samples of rusted iron/metal objects

Clean iron nails

Water, saltwater, oil

Test tubes/plastic bottles, cotton wool, and beakers

Drying agent (Calcium chloride)

Video or animation on corrosion/rusting

Researcher Instructional Activities

Introduction: The researcher introduced the lesson by showing images of rusted objects, such as rusted nails, and asked students if they had seen similar examples in their lives. Students mentioned rusted walls, bicycles, machine parts, and playgrounds as their responses.

Activity 1: Through flexible grouping and small group discussions, the researcher guided students to establish what they know about corrosion and rusting of metals. Research allowed students to brainstorm. While moving around to supervise them in their groups, the researcher allowed his students to express themselves as he posed questions. The researcher then gave clarifications and further explanations.

Corrosion is the chemical reaction that causes metals to wear away gradually when they react with air and moisture. When corrosion persists for a long time, it results in rust.

Rusting specifically refers to the corrosion of iron.

Rust is the reddish-brown coating on the surface of iron or steel that forms when the metal is exposed to air and moisture.

When iron reacts with oxygen or moisture, in a process known as corrosion, iron (III) oxide (hydrated iron oxide) is formed. This iron (III) oxide is a thin reddish-brown layer that forms on the surface of the iron called rust.



Figure 2: *Diagram of a rusted nail*



Figure 3: *A diagram shows the rusting of iron.*

Activity 2: In some small groups, students are asked to discuss and identify the possible conditions that may cause metals to corrode or rust in the environment. Through hands-on experiments with the same groups, the researcher provided all the necessary apparatus for students to demonstrate that air and water are the most necessary conditions for the rusting of iron. The researcher demonstrated to students before allowing them to proceed with experimental tasks. Students were asked to write down what they discovered and discussed at the end of the activities. Students are asked to carefully follow the instructions and procedures.

INSTRUCTION: In your groups, perform the following activities below

APPARATUS: 3 Clean iron nails, 3 Test tubes, 3 stoppers, Dry cotton, Water, and Oil

Procedure to follow

(I) Label the three test tubes as A, B, and C with stoppers.

(II) Place a nail in each test tube.

(III) Fill test tube A with ordinary tap water and stopper it. (Tap water contains dissolved oxygen)

(IV) Also, fill test tube B with the freshly boiled water (dissolved oxygen removed), then add a layer of oil and stopper it. Thus, the layer of oil prevents fresh air from entering the water again.

(V) Put a dry cotton in test tube C and cover with a stopper.

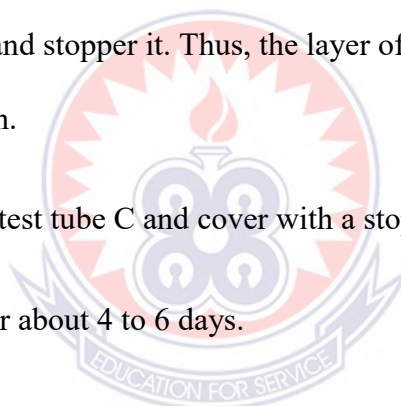
(VI) Leave the setup for about 4 to 6 days.

(VII) Write down your observations

(VIII) Conclude your analysis

The necessary conditions for corrosion or rusting of iron to occur are water (moisture or vapour) and air (oxygen).

Factors that influence corrosion include temperature, humidity, presence of salts and acids.



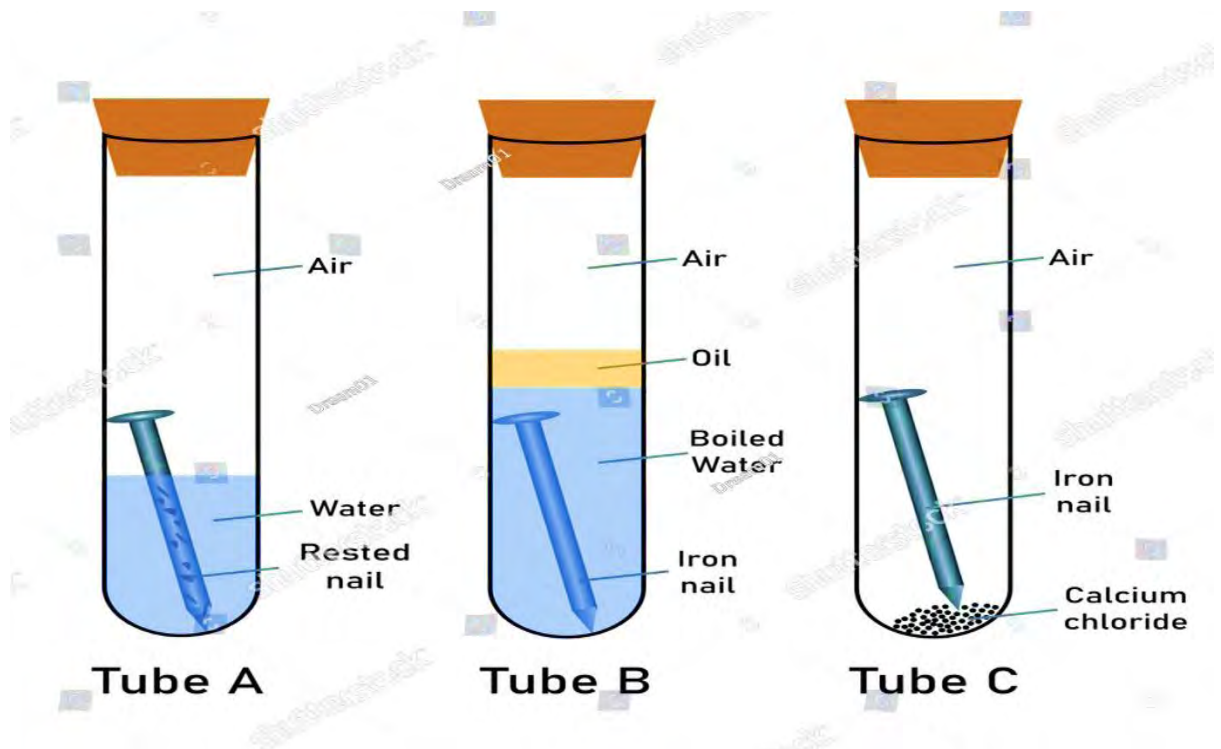


Figure 4: Diagram to demonstrate the conditions necessary for the rusting of iron to occur.

Observation: After four days, it was observed that the nails in test tube A had begun rusting, while the nails in test tubes B and C showed no sign of rusting.

Conclusion: Test tube A, which contains both water and air, supports rusting, while test tubes B and C, which have water only and air only, respectively, do not support rusting. Therefore, both water and air are necessary for rusting.

Activity 3: With the chart of rusted objects shown to students, in small groups, students are asked to discuss how corrosion and rusting can affect objects or metals in their environment. The researcher then assisted students in clarifying their points.

Effects of corrosion and rusting on metals. Corrosion and rusting have several detrimental effects on metals:

- Weakens metal structures by reducing strength and integrity

- Causes material loss through surface deterioration
- Leads to high economic costs due to repairs and replacements
- Shortens the lifespan of metal products and infrastructure
- Creates safety hazards from unexpected failures
- Damages appearance by causing rust and discolouration

Activity 4: Through small group discussion with the same grouping, students are facilitated to discover ways that can be used to prevent metals such as iron from corrosion or rusting. The researcher asked questions that are good for sparking curiosity and engaging students in discussion about the prevention methods for corrosion and rusting. Students were then asked to note their points as they discussed in groups. Each group is called out to present their ideas. The researcher acknowledged students' contributions and reshaped them for them. The effective methods to prevent rusting include;

Painting: Applying paint on the surface of iron to create a barrier between the iron and moisture/oxygen

Galvanisation: Coating iron with a layer of zinc to protect it from rusting.

Powder coating: A dry powder is applied to the surface of iron, creating a protective layer.

Plastic coating: Metals are coated with a thin film of plastic to prevent rusting.

Alloying: Mixing iron with metals such as chromium and nickel to prevent corrosion or rust.

Electroplating: In electroplating, the iron is placed in a solution and is connected to the negative terminal, with the coating metal connected to the positive terminal of an

electricity source. Current is then allowed to pass through, which causes atoms from the coating metal to move to cover the surface of the base iron.

Tinplating: Involves coating the surface of the iron or steel with a thin film of tin, which makes it resistant to rusting.

Oiling and greasing: Applying oil and grease on a metal surface to provide a protective layer that prevents moisture and oxygen contact.

Cladding: Cladding is the process of bonding a non-corroding metal to a corrosive metal to create resistance to rusting.

Enamelling: Involves coating the surface of the metal with enamel. Enamel is a special paint that consists of zinc oxide and lithopone in brown linseed oil and high-grade varnish.

CONCLUSION: Through a whole-class discussion, students asked questions for clarification. The researcher reviewed all the key points, ensuring students' understanding and retention of knowledge. The researcher concluded the lesson by asking students to conduct further research.

LESSON 2

TOPIC: Force

Relevant Previous Knowledge (RPK): Students perform everyday actions involving force, such as pushing a chair, using a catapult, pulling a drawer, and closing a door.

Objectives: By the end of the lesson, students will be able to:

- 1) define force
- 2) outline various types of forces.
- 3) demonstrate the effects of the force of an object
- 4) state Archimedes' Principle and the law of floatation.

Differentiated Instruction Strategies:

Flexible grouping, Tiered activities, Whole class discussions, Demonstrations, Hands-on experiments and Small-group discussion, Assessments (class discussions, report, oral questions, observation)

Instructional Resources:

Diagrams/ Simulations of forces (push, pull, friction, gravity, tension)

Magnets, Toy car, Objects (Stones), Catapult, Spring, Rubber bands, Eureka can, Plastics, Metals, Balloons, Graduated beaker, Thread, Spring balance, and Electronic balance.

Researcher Instructional Activities

Introduction: The Researcher asked students, have you ever pushed a door or pulled a rope? Images are displayed showing forces in action, such as a car moving, a ball rolling, magnet attracting.

Activity 1: Through tiered activities, the researcher put students into flexible groups. The researcher designed three tiers of activities that vary in complexity and depth to help students learn the concept of force. Research allowed students to brainstorm in their groups. The researcher then guided the students in tiered activities.

Tier tasks:

Tier 1 Task: For basic understanding, the researcher assisted students in creating flashcards that are key terms related to force. Students were asked to explain the terms to a partner or in small groups. It helped students familiarise themselves with basic terminologies and concepts.

The terms related to force include pull, push, lift, drag, friction, weight, and gravity.

Tier 2 Task: Students conducted simple experiments to observe forces in action by throwing objects like stones in the air, compressing plastic bottles, and displacing boxes on the surfaces of tables to explore gravity and friction. Students were able to apply their understanding of force in a hands-on way by explaining what they observed about the force acting on the objects (stones) and boxes. The researcher then assisted students in understanding the concept of force.

Force is a push or pull on an object resulting from the interaction of the object with another object. The interaction between objects can cause an object to change its shape, direction, and velocity. It is a vector quantity (has both magnitude and direction). The SI unit of force is newton (N). Newton is the amount of force required to give **1 kg** of mass an acceleration of **1 m/s²**. Force can be expressed mathematically as **$F = ma$** , where **F** is the net force, **m** is the mass of the object, and **a** is the acceleration due to gravity. Thus, **$a = g$**

Tier 3 Task: Researcher guided students to analyse the phenomena of force and apply Newton's formula to solve problems in their groups. Students were asked to present their results in a group presentation. Students were told to synthesise the knowledge and apply it in any complex situations.

A car with a mass of 120 kg accelerates at a rate of 3 m/s^2 . Calculate the amount of force acting on the car.

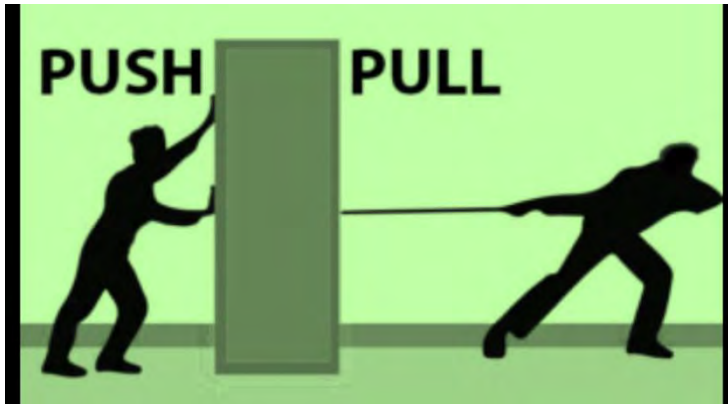


Figure 5: *Diagram to demonstrate force.*

Activity 2: With flexible grouping, the researcher offered students materials such as magnets, catapults, rubber bands, nails, and stones. In the small groups, students were asked to interact and demonstrate to identify the various forces involved in the actions. Students' demonstrations include throwing stones in the air, rubbing a comb on the head (hair), stretching a rubber band, putting a stone and wood in the oil and water. Students were to present their findings concerning forces. The researcher reshaped the concepts and put them into categories for his students through class discussions.

The various types of forces include friction, tension, force of gravity, gravitational force, normal force, electrostatic force, magnetic force, viscosity, centripetal force, and centrifugal force.

Categories of forces: Contact and non-contact forces.

Contact forces occur when two or more objects physically contact each other. These forces include friction, normal force, tensional force, viscosity, weight, upthrust, and others.

Non-contact forces are those forces that act over a distance without physical contact. They include electrostatic force, electromagnetic force, and gravitational force.

Activity 3: In their small groups, students are asked to push the toy car lightly, then push it harder and observe how the speed changes. Again, in demonstration, students are made to stretch the catapult in their groups to observe any change. Students are asked to discuss their observations. The researcher assisted students in clearly stating the key points.

Effects of Force: Force on an object can change its shape, direction, speed, and cause it to start or stop moving.

Activity 4: The Researcher allowed students in their small groups to brainstorm to explain the concept of flotation. In a demonstration, students were asked to put a piece of wood into a container with water and observe the phenomena. Again, students are facilitated to experiment using an eureka can filled with water and allowed to stop dripping from the spout. The object (stone) weight is determined with a spring balance tied with a thread. Students measured the weight of water in the beaker after slowly submerging the stone to show how much water was displaced. Students compared the weight loss of a stone to the weight of the volume of stone displaced. Students discussed their findings among themselves in the groups. Concepts clarified by the researcher.

Instructions and procedures laid down by the researcher for students to follow

APPARATUS NEEDED: Eureka can, graduated beaker, stone, thread, spring balance, and electronic balance.

- I. Attach a thread to a solid object (stone).
- II. To find the weight of the stone in air, wrap the thread around the spring balance's hook (W_1).
- III. Pour water into an Eureka can and let it stop spilling from the spout.
- IV. Place a beaker of known weight W_2 beneath the Eureka can's spout.
- V. Lower the solid object that is suspended from the spring balance gently into the water in the Eureka can. Record the spring balance's reading as W_3 once the object is completely submerged.
- VI. Allow the spout of the Eureka can to stop dripping water into the beaker. Record the weight of the beaker and the water as W_4 .

Calculations

Weight of object in air = W_1

Weight of object in water = W_3

Loss of weight of object = $W_1 - W_3$

Weight of empty beaker = W_2

Weight of beaker and water = W_4

Weight of displaced water = $W_4 - W_2$

Observation: It would be observed that the loss in weight of object $W_1 - W_3$ equals the weight of displaced water. That is $W_1 - W_3 = W_4 - W_2 =$ upthrust (buoyant force) of the object.

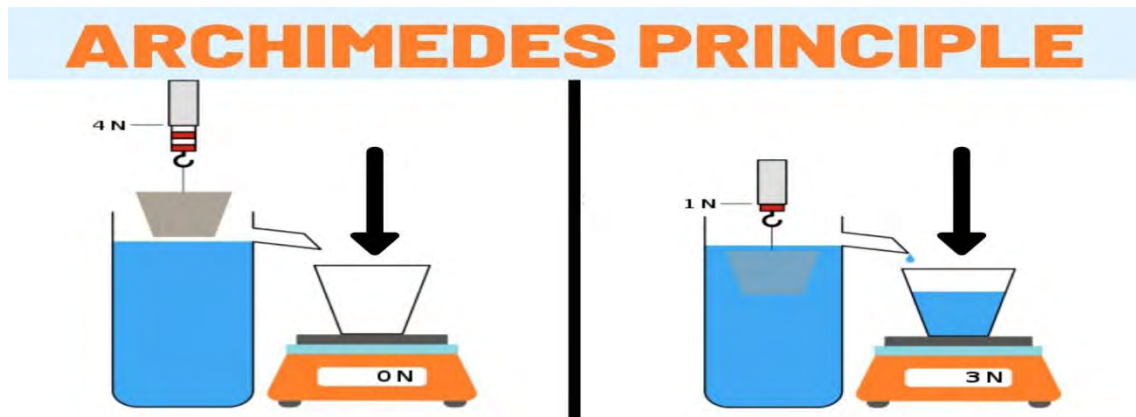


Figure 6 : *Diagram showing Archimedes' principle*

Conclusion: This concludes that the amount of fluid displaced by an object equals its weight. This is known as the law of flotation.

Upthrust is the upward force that prevents a floating body from sinking to the bottom of a fluid.

Archimedes' principle states that an object immersed in a fluid displaces an amount of the fluid which is equal to its weight.

Thus, when an object is submerged in a fluid, it experiences an upward force due to the pressure difference between the bottom and top of the object. Therefore, we call this upward force the buoyant force.

The law of flotation states that a floating body displaces its own weight of the fluid it floats in.

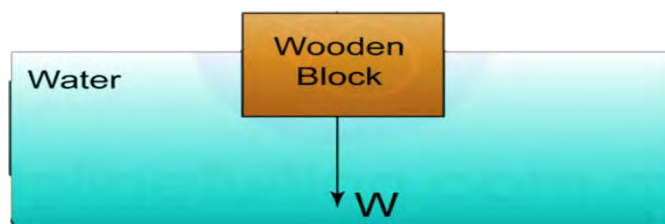


Figure 7: *The flotation of objects*

The Conditions for Floating to Occur:

An object floats when the buoyant force (upthrust) acting on it equals its weight.

Every floating object displaces its own weight with the fluid in which it floats.

Relationship to Density: When the density of an object is less than the density of the fluid, then it will float. Also, when the object's density is greater than compared of the fluid, it will sink.

Archimedes' principle explains the buoyant force experienced by a submerged body, whilst the law of floatation explains when a body floats in fluids based on the balance between buoyancy and weight.

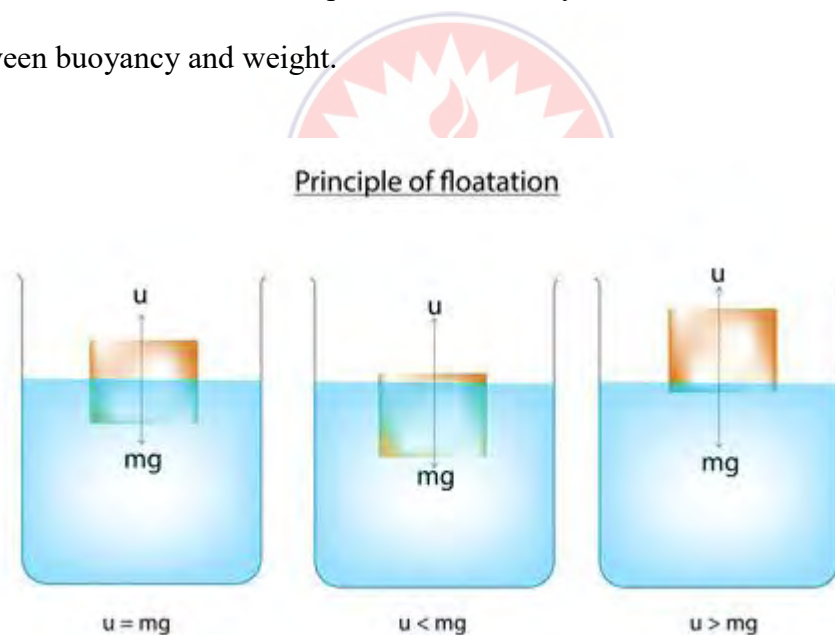


Figure 8: Diagram to show the principle of floatation.

CONCLUSION: The Researcher engaged students in a whole-class discussion to consolidate learning. Students asked questions for clarification. The researcher provided answers to ensure students' conceptual understanding, and the key points were reviewed at the end lesson.

LESSON 3

TOPIC: Germination of Seeds

Relevant Previous Knowledge (RPK): Students understand the nature of seeds and plants in the environment. Students grow crops on the farms with seeds and seedlings. The students have learned about reproduction in plants.

Objectives: By the end of the lesson, students will be able to:

- 1) explain germination and dormancy
- 2) identify the conditions necessary for seed germination
- 3) describe the stages of germination.
- 4) demonstrate the conditions necessary for germination with an experiment.

Differentiated Instructional Strategies: Flexible seating, Whole class discussions, Hands-on experiments and Small-group discussion, Assessment (Group work, Oral questions and answers)

Instructional Resources:

Chart showing the stages of seed germination

Viable seeds (beans)

Transparent containers/Test tubes/ Plastic bottles

Cotton wool or paper towels

Water, Oil, Ice Cube/Refrigerator or Freezer

Light source (window)

Multimedia: Short video animation on seed germination

Labelled diagram of a seed showing radicle, plumule, etc.

Researcher Instructional Activities

Introduction: The researcher introduced the lesson by showing an image of a bean seed sprouting to the students. The researcher asked students to learn about seeds and plants. “*What do you think seeds and plants need to grow?*” Based on their prior knowledge, students mentioned water, air, temperature, and sunlight.

Activity 1: In a whole-class discussion and flexible seating, the researcher facilitated students to explain the terms germination and dormancy in seeds. Based on students’ responses, the researcher then clarified their misconceptions and provided additional explanations.

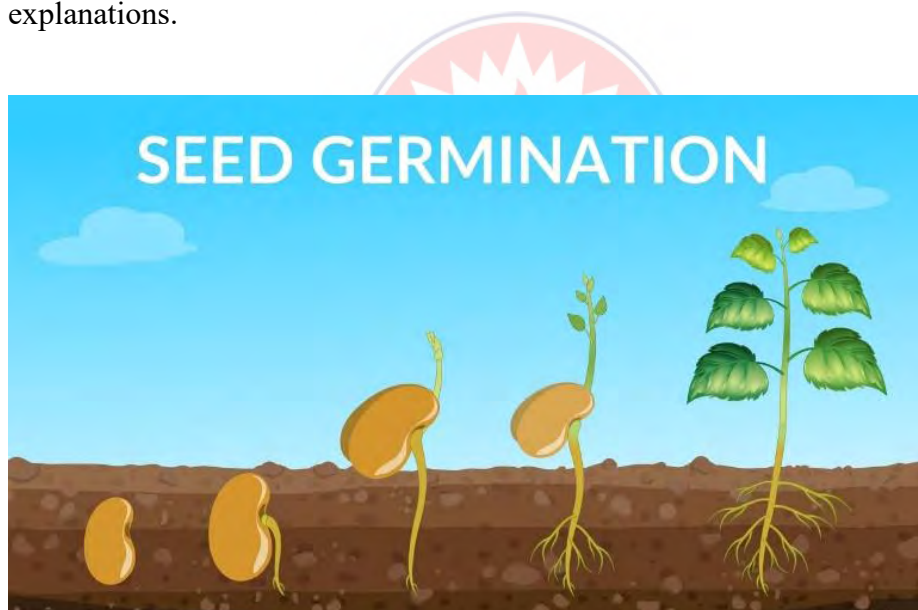


Figure 9: A Diagram shows the germination of a bean seed.

Germination is the process whereby the embryo emerges from the seed coat because of the growth of the seed into a seedling. Seeds may germinate immediately or undergo a period of dormancy after their dispersal.

Dormancy is the stage during which growth stops temporarily, and metabolism is reduced to the lowest rate. Dormant seeds may survive adverse conditions like drought, flood, and irregular temperatures.

Activity 2: Through small group discussion, the researcher guided students in five groups to identify the possible conditions that could enable the seed to germinate. The researcher allowed each group to share their views in class. The researcher clarified that for a seed to germinate, it must first be viable. The researcher then assisted his students with points that were considered the necessary conditions for seed germination. The necessary conditions include moisture/water (softens the seed coat and activates enzymes), oxygen/air (for respiration), warmth/suitable temperature (to activate enzymes), and the viability of the seed.



Figure 10: Diagram demonstrating a viable bean seed

Activity 3: The Researcher shows a diagram or animation for each stage to students in groups. Students are asked to discuss their observations. The researcher polished the points for the students. Stages of germination include.

- i. Absorption of water
- ii. Swelling of the seed
- iii. Breaking of the seed coat
- iv. Growth of radicle (The root)
- v. Growth of plumule (The shoot)



Figure 11: *Diagram showing stages of seed germination*

Activity 4: Through hands-on experiments with the same groups, the researcher provided all the necessary apparatus for students to investigate the conditions necessary for germination of the seed. The researcher laid down clear instructions and procedures for the participants to follow.

INSTRUCTION: In your groups, perform the following activities below

APPARATUS NEEDED: 4 Viable bean seeds, Water, Cotton wool, 4 Plastic bottles, a Freeze/Ice cube, and Oil.

PROCEDURE

- (I) Label four plastic bottles A, B, C, and D.
- (II) Put a piece of cotton wool and the four seeds into each plastic bottle.
- (III) Pour a few drops of water into plastic bottles A and D.

- (IV) Leave plastic bottle A at room temperature
- (V) Put plastic bottle D in ice cubes or the refrigerator to get rid of warmth.
- (VI) Also, leave the contents of plastic bottle B dry.
- (VII) Heat water to remove dissolved air (oxygen), allow the water to cool, and pour a few drops into plastic bottle C. Pour oil into the water to form a layer on the surface to prevent oxygen from entering.
- (VIII) Leave the setup for about seven days and observe what happens then.
- (IX) Write down your observations from the experiment and discuss them in your group
- (X) Conclude from your observations and discussions

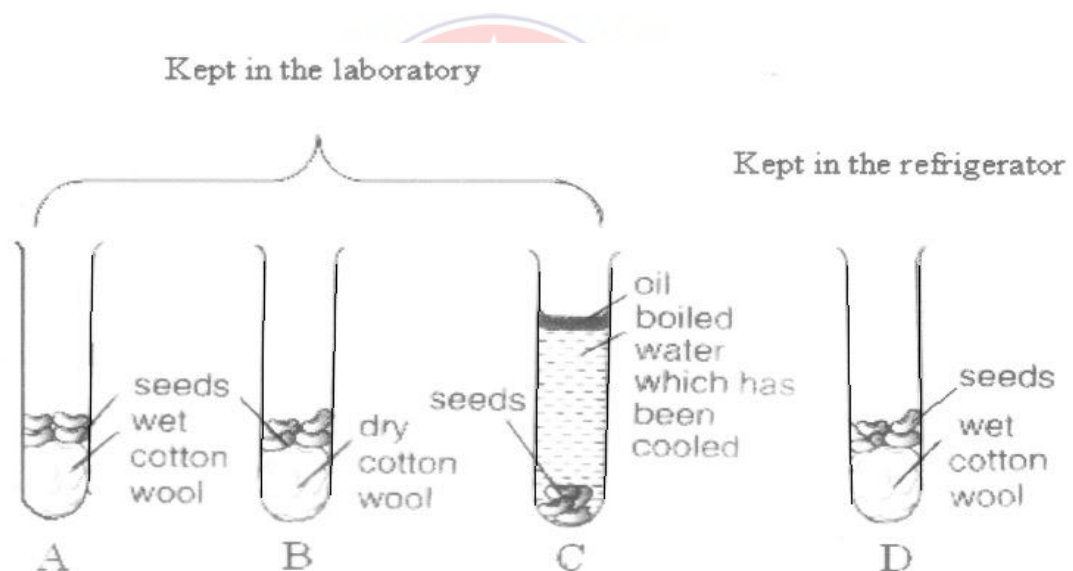


Figure 12: Diagram to investigate the conditions necessary for germination of bean seeds.

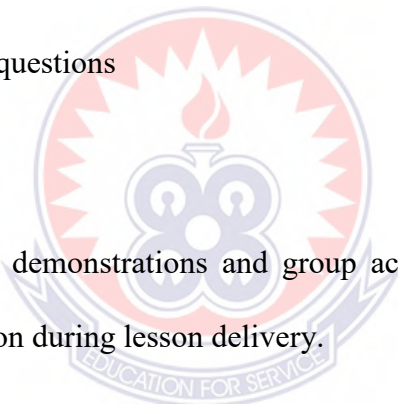
Observation: It would be observed that only the seeds in plastic bottle A germinate. The others failed to germinate. Because the seeds in plastic bottle A, which have all the conditions for germination, germinate, while the other seeds, which lack one condition, do not germinate.

Conclusion: This shows that a viable seed needs all the necessary conditions, water, air, and warmth to germinate.

CONCLUSION: The Researcher concluded the lesson by conducting a whole-class discussion to consolidate learning. Students asked questions for clarification. The researcher provided answers, ensuring all students understood the concepts and the key points stated at to end lesson.

The techniques used by the researcher in his lessons delivery on the experimental group include,

- I. Active learning.
- II. Asking strategic questions
- III. Scaffolding
- IV. Using classroom demonstrations and group activities to encourage students' active participation during lesson delivery.
- V. Reflective practice
- VI. Using motivation to stimulate the students' interest in learning



3.9 Post-Treatment

The post-test was administered to both experimental and control groups after the treatment to determine whether there would be significant differences between them based on their understanding and retention of the concepts taught during the integrated science lessons. This assessment determined differences in students' performance after establishing the treatments. The post-test consists of 30 multiple-choice questions, and

it was scored over fifteen. Each item has a score value of 1 mark. Finally, the researcher administered the questionnaire to the students.

3.10 Data Analysis Technique

The process of choosing codes and creating themes in the thematic analysis process entails interpretation in addition to data description (Kiger & Varpio, 2020). Creswell (2021) states that theme analysis, a technique for finding, examining, and summarising patterns in data, is used to study qualitative data. Themes have been used to guide a qualitative analysis of the information gathered from the open-ended questionnaire and interview. The data collected from the pre-test, post-test, and closed-ended questionnaire were quantitatively analysed using descriptive statistics such as mean, standard deviation, and percentage. The researcher used a t-test in his inferential statistics. The independent test was used to determine if there is a significant difference in the mean scores of the experimental and control groups. SPSS was used to facilitate data analysis and enhance accuracy.

3.11 Ethical Considerations

The researcher ensured that the study strictly adhered to established ethical considerations. This involved obtaining informed consent from all participants, safeguarding the confidentiality of their personal information, and ensuring that no harm, whether physical, psychological, or emotional, was caused to them throughout the research process.

3.12 Conclusion

This chapter has presented the research methodology used in investigating the effect of differentiated instruction on SHS2 General Art2 students' performance in integrated science. The chapter discussed the research design, population and sample, data

collection instruments, validity and reliability of the research instrument, data collection procedure, data analysis technique, and ethical considerations.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter presents the study's findings on the effect of DI on students' performance in integrated science. It entails the demographic information of the study participants. The chapter presents the results obtained from the collected data, which include both descriptive statistics and inferential statistics. The results are analysed and discussed in relation to the research questions based on the objectives.

4.1 Demographic Data of Participants

The demographic information of the participants in the study.

Forty-four (44) students are involved in the study. With regards to the gender of students, 40.90% of the students are males, while the remaining 59.10% are females. The students have an average age of 17 years.

The sex and age distribution of teachers who participated in the study. The male teachers form 86.70% while female teachers form 13.30%. In terms of age, out of the 15 respondents, none were below 20 years, while 20.00% fell within the 20–30 years category. The largest group, representing 40.00%, was between 30–40 years, followed by 26.67% who were between 40–50 years, and 13.33% who were above 50 years. Most of the teachers were in their 30s and 40s, an age range often associated with a balance of professional experience and active engagement in teaching. The presence of younger teachers (20–30 years) reflects an infusion of recent graduates into the profession, many of whom may have been exposed to modern teaching strategies,

including differentiated instruction. The smaller representation of teachers above 50 years suggests limited involvement of highly experienced teachers, although their presence still adds professional wisdom to the teaching staff. The distribution shows a clear gender disparity among the teaching staff, with a significantly higher representation of male teachers compared to their female counterparts.

Table 1 shows the distribution of teachers according to working experience.

In table 1, the majority (66.70%) of the teachers in the sample have more than 6 years of teaching experience, with the largest group (40.00%) having over 10 years. Few (33.30%) teachers are less experienced. This suggests a predominantly experienced teaching workforce, which may contribute positively to instructional quality and stability in the classrooms.

Table 1: Years of Teachers' Experience

Years of experience	Frequency	Percentage (%)
Less than 2	2	13.30
2-5	3	20.00
6-10	4	26.70
More than 10	6	40.00
Total	15	100.00

Source: Researcher Data (2025)

4.2 Presentation and Discussion of Results According to the Research Questions

4.2.1 Research Question One: What is the effect of differentiated instruction on students' academic performance in the topics of corrosion and rusting of iron, force, and germination of seed in Integrated Science?

This research question aimed to determine the effect of differentiated instruction on the academic performance of students in SHS based on the selected concepts in Integrated

Science. To provide answers to the research question posed first, a pre-test was conducted for students in both the Experimental and Control groups to determine their base performance before the implementation of the treatment. A null hypothesis was tested to determine whether there was a statistically significant difference in students' performance in the pre-stage.

4.2.1.1 Null Hypothesis:

Null Hypothesis (H_{01}): There is no statistically significant difference in students' performance at pre-test between both groups ($\mu_1 = \mu_2$) with respect to the topics, corrosion and rusting of iron, force, and germination of seed.

The independent samples t-test was conducted to compare the pre-test scores of students in the experimental and control groups. Results are indicated in Table 2.

In Table 2, the experimental group ($n = 29$) obtained a mean score of $M = 14.51$ ($SD = 8.95$), whereas the control group ($n = 15$) recorded a mean score of $M = 14.14$ ($SD = 8.01$). The observed mean difference between the two groups was 0.37, with $df = 42$. At the predetermined level of significance ($\alpha = .05$), only this observed mean difference can not be used to conclude that there was no statistically significant difference between the two groups in the pre-test scores.

Table 2: Group Statistics of Students' Performance at Pre-test

Group	N	Mean	SD	Df	Md
Experimental	29	14.51	8.95	42	0.37
Control	15	14.14	8.01		

Statistically significant level (Alpha) $\alpha = 0.05$

To determine whether this difference was statistically significant in means of pre-test scores, a t-value, p-value and Cohen's d value were calculated. The data presented in

Table 3 compares the pre-test performance of students in experimental and control groups with an independent samples t-test before the implementation of the treatment.

As shown in Table 3, the experimental group ($n = 29$, $M = 14.51$, $SD = 8.95$) and the control group ($n = 15$, $M = 14.14$, $SD = 8.01$) achieved very similar mean scores. The results indicated that the difference between the groups was not statistically significant, $t(42) = .14$, $p = .89$ (*two-tailed*), $d = .04$. Since the obtained p -value exceeded the alpha level ($\alpha = .05$), and the Cohen's d value is well below the threshold for a small effect ($d = 0.2$), indicated that there was no meaningful difference between the groups, and the null hypothesis of no difference was retained. This pre-test analysis confirms that both groups were comparable and provides a reliable foundation for subsequent evaluation of treatment effects. Thus, it is concluded that the difference in mean scores between the experimental and control groups was not statistically significant. As the results confirmed that both groups were at the same level of understanding the selected concepts, the researcher proceeded with the treatment.

Table 3: Independent Test Analysis of Students' Performance at Pre-test

Group	N	Mean	SD	df	t-value	p-value	Cohen's d
Experimental	29	14.51	8.95	42	0.14	0.89	0.04
Control	15	14.14	8.01				

Statistically significant level (Alpha) $\alpha = 0.05$, $p < 0.05$

Null hypothesis (H_{02}): There is no statistically significant difference in students' post-test scores between those taught the topics using DI and those taught using traditional teaching methods.

After the pre-test, the experimental group was taught corrosion and rusting of metals, force, and germination of seed for six weeks using differentiated instructional approach,

whilst the control group was also taught the same topics for the same period using the traditional method. At the end of the six weeks, both groups were tested using the post-test items.

As shown in Table 4, the experimental group ($N = 29$) had a higher mean score ($M = 19.86$, $SD = 6.71$) than the control group ($N = 15$), which had a mean score of 15.01 ($SD = 7.01$). The mean difference (Md) between the groups was 4.85.

With a degree of freedom (df) of 42 and an alpha level of .05, the results suggest that there is a big difference between the two groups' performance on the post-test.

The higher mean in the experimental group suggests that the treatment administered to this group may have had a positive effect on students' post-test performance compared to the control group, which did not receive the same treatment.

The relatively high standard deviations in both groups indicate a wide variability in scores, particularly in the control group ($SD = 7.01$), suggesting individual differences in performance. However, to confirm statistical significance, the actual t -value and p -value from the t -test are required. The independent samples t -test was conducted to compare the post-test scores of students in the experimental and control groups. If the p -value is less than the alpha level ($p < .05$), the difference in performance is considered statistically significant, indicating that treatment had a meaningful effect on students' scores. Therefore, a definitive conclusion can be drawn regarding the effectiveness of differentiated instruction in the intervention process.

The table 4 presents the post-test scores of students in both groups.

Table 4: Group Statistics of Students' Scores at Post-test

Group	N	Mean	SD	df	Md
Experimental	29	19.86	6.71	42	4.85
Control	15	15.01	7.01		

Statistically significant level (Alpha) $\alpha = 0.05$

Thus, to confirm the statistical significance in the post-test scores between the two groups, the t-value, p-value, and Cohen's d are determined.

The data presented in Table 5 compares the post-test performance of students in experimental and control groups, using t-test analysis after the implementation of the treatment (DI).

From Table 5, the experimental group (n = 29) achieved a higher mean score of $M = 19.86$, with a standard deviation of $SD = 6.71$, while the control group (n = 15) recorded a lower mean score of $M = 15.01$, with a standard deviation of $SD = 7.01$. These results indicate an improvement in the performance of the experimental group compared to the control group after the treatment was applied to the experimental group.

The results indicated a statistically significant difference in post-test performance, $t(42) = 2.21$, $p = .03$, $d = .71$. Since the p-value is less than the alpha level of 0.05, and Cohen's d of 0.71, indicating a moderately large effect size, the null hypothesis is rejected. This implies that the observed difference in mean scores between the experimental and control groups is statistically significant. The null hypothesis was rejected based on these results.

Table 5: Test analysis of students' performance at post-test

Group	N	Mean	SD	df	t-value	p-value	Cohen's d
Experimental	29	19.86	6.71	42	2.21	0.03	0.71
Control	15	15.01	7.01				

Statistically significant level (Alpha) $\alpha = 0.05$, $p < 0.05$

This finding suggests that the DI used in teaching students in the experimental group had a positive impact on their performance on the Selected Concepts (corrosion and rusting of metals, force, and germination of seed) in Integrated Science. The significant increase in mean scores for the experimental group, compared to the control group, provides evidence that the DI contributed to improved academic outcomes. Although both groups showed variability in their scores, the direction and significance of the difference support the effectiveness of the differentiated instruction.

Students' performance in the control group did not improve significantly because they were taught with a traditional approach, which is a one-size-fits-all approach and did not adequately support all the students. This aligned with Smit and Humper (2012), who based their findings that students learn best using their preferred learning style and yet some teachers ignore this fact, and they do not allow the learners to learn using their preferred learning style.

The results of several other studies that employed differentiated instruction have similar reportage. The findings also align with Ismajli and Imami-Morina (2018), who reported that the use of differentiated instruction is critical in meeting the unique requirements of pupils. Recognising the importance of adapting instructional methods to meet student needs, teachers must emphasise the implementation of differentiated instruction to successfully help students in reaching their learning objectives.

Tomlinson and Moon (2021) reported that students in classrooms utilising differentiated strategies showed significant gains in achievement compared to those in traditional settings. Studies by McCoy (2010) indicate that students who experience differentiated instruction report higher levels of motivation and satisfaction with their learning experiences. This finding resonates with Wiselby (2014), who emphasised that DI creates multiple avenues for learners in terms of what they learn, how they learn, and how they express their knowledge. Such flexibility ensures that instruction meets the diverse needs of students in their respective classrooms. The results further indicated that Integrated Science teachers are expected to apply DI across four key dimensions: content, process, product, and learning environment. Differentiating content ensures that instructional materials are tailored to students' readiness levels. Differentiating the process allows teachers to design varied activities that help students construct meaning in ways suited to their learning styles. Differentiating products provides learners with alternatives for demonstrating mastery, while differentiating the learning environment creates a classroom atmosphere that promotes inclusivity, collaboration, and autonomy. Researcher's findings align with Tomlinson's (2014) model of differentiation, which indicates the importance of adapting these four elements to maximise student engagement and achievement. The findings revealed that the use of pre-assessments was instrumental in helping teachers understand students' prior knowledge, readiness levels, and learning gaps. This enabled teachers to plan lessons more effectively and align instruction with students' individual needs. These results support the work of Turner et al. (2017), who emphasised that pre-assessments provide valuable information for lesson preparation and instructional differentiation. Implementing DI allows teachers to address the varying skill levels, readiness, and abilities of students within the same classroom. As Smit and Humpert (2012) and

Tomlinson and Imbeau (2010) emphasise, differentiation ensures that no student is left behind by providing instruction that is aligned with individual learning profiles. This approach moves beyond a one-size-fits-all method and instead embraces flexibility to accommodate a range of learners. This finding is consistent with Fitzgerald's (2017) and Lauria's (2010) research, suggesting that practising DI leads to increased learner participation, improved test scores, and a deeper sense of ownership over the learning process.

4.2.2 Research Question Two: What attitudes do students have regarding the use of differentiated instruction strategies in the teaching and learning of Selected Concepts (Corrosion and rusting of metals, force, and germination of seed) in Integrated Science lessons?

This question sought to investigate students' attitude toward the use of a differentiated learning approach in the teaching and learning of selected concepts in Integrated Science. To achieve this objective, data were collected using both closed-ended and open-ended questionnaires, which were administered to students in the Experimental Group.

4.2.2.1 The quantitative analysis for students' attitude towards the use of the differentiated instructional (DI) approach in Integrated Science lessons.

Students' responses to items in the close-ended questionnaire were measured on a 5-point Likert scale. The responses of students in the experimental group towards differentiated instruction are shown in Table 6.

Table 6 reveals that most students in the experimental group hold positive attitudes toward differentiated instruction (DI). Specifically, 55.17% agreed and 34.48% strongly agreed that the use of varied teaching strategies enhances their active

engagement. This finding supports Tomlinson's (2014) assertion that incorporating diverse instructional methods fosters greater student participation. Hence, teaching selected concepts, such as the rusting of iron, through a combination of demonstrations, hands-on experiments, and multimedia resources makes abstract content more accessible and engaging for diverse learners in the classroom.

Regarding motivation (Item 2), 51.72% of students agreed and 27.59% strongly agreed that modifying lessons to suit different learning styles increased their motivation to learn Integrated Science. This aligns with Hall's (2002) emphasis on the motivational benefits of tailoring instruction to meet individual learning preferences. Interactive activities such as demonstrations of force using physical experiments alongside verbal explanations can cater to kinaesthetic and auditory learners, thereby enhancing motivation.

Concerning students' interest (Item 3), 48.28% agreed and 37.93% strongly agreed that DI made learning Integrated Science concepts more interesting. This is consistent with Tomlinson and Imbeau's (2010) findings that differentiated instructional strategies enrich students' intrinsic interest and enjoyment by addressing varied cognitive and affective needs. Thus, lessons on seed germination that integrate time-lapse videos, experiments, and group discussions create a dynamic learning environment that stimulates curiosity and promotes deeper understanding.

When asked about their preference for DI versus traditional lecture methods (Item 4), 41.41% agreed and 31.03% strongly agreed that they preferred DI. Although some students remained neutral or disagreed, there was a general positive reception. Heacox (2017) supports these findings by indicating the benefits of student-centred instructional approaches, which prioritize learner engagement and autonomy over

traditional lecture methods. The preference for DI reported by students shows that when students are actively involved in their learning process, they develop positive attitudes toward the subject matter and the instructional approach. Such positive attitudes are essential for fostering a supportive learning environment that encourages academic achievement.

Item 5 assessed students' general appreciation for the use of differentiated instruction in the teaching and learning process. An overwhelming majority of students, 86.24%, responded positively (*Agree* or *Strongly Agree*), with only 10.34% expressing disagreement or neutrality. This indicates that students not only accepted DI as a teaching method being used in teaching the selected concepts but also valued its implementation within the Integrated Science classroom. This finding is consistent with Santangelo and Tomlinson (2009), who found that when instruction is differentiated, students are more likely to feel that their individual learning needs are acknowledged and accommodated, which can lead to a more active and self-directed approach to learning. Findings proved that students feel more supported and engaged in environments where instruction is adjusted to meet their diverse learning needs.

The findings suggest that differentiated instructional approaches in Integrated Science are well-received by students, promoting engagement, motivation, interest, and preference over traditional lectures. And such positive attitudes are crucial for successful implementation and may lead to improved academic outcomes in Integrated Science (Tomlinson, 2014). Thus, applying differentiated instructional strategies when teaching complex scientific phenomena, such as the rusting of iron, force, and seed germination, makes learning more tangible and effective in meeting students' diverse needs in class.

Table 6: Students' Attitudes towards Differentiated Instructional Approach

Item	Strongly Disagree <i>f</i> (%)	Disagree <i>f</i> (%)	Neutral <i>f</i> (%)	Agree <i>f</i> (%)	Strongly Agree <i>f</i> (%)
1. When the teacher implements a variety of teaching strategies in class, I become more actively engaged.	0 (0.00)	1 (3.44)	2 (6.90)	16(55.17)	10(34.48)
2. I am more motivated to learn Integrated Science when lessons are modified to different learning styles.	1 (3.44)	2 (6.90)	3(10.34)	15(51.72)	8 (27.59)
3. Differentiated instruction makes learning concepts in Integrated Science more interesting.	0 (0.00)	1 (3.44)	3(10.34)	14(48.28)	11(37.93)
4. I prefer differentiated instruction over traditional lecture methods.	2 (6.90)	2 (6.90)	4(13.79)	12(41.41)	9 (31.03)
5. I appreciate differentiated instruction when used in the teaching and learning process in class	1 (3.44)	2 (6.90)	1 (3.44)	13(44.83)	12(41.41)

f = frequency, % = percentage in parentheses, N = 29

4.2.2.2 Quantitative Analysis for Students' Attitude towards DI in Integrated Science Lessons

The qualitative analysis of the open-ended questionnaire from the experimental group is presented in response to Research Question 2.

A total of 29 students were asked to respond in writing to the open-ended item: “*What do you like or dislike about using various learning activities when studying Integrated Science?*”

Results presented based on the researcher’s thematic analysis in line with Braun and Clarke’s (2006) method.

Theme 1: Participation Builds Confidence

Most students frequently described participatory activities such as classroom discussions, experiments, and hands-on learning as both enjoyable and empowering. These instructional strategies were reported to enhance students' confidence and improve a deeper understanding of scientific concepts. One respondent emphasised the importance of active involvement by stating: “*I feel more involved in class when I can actually do something rather than just listen.*”

This aligns with findings from McCoy (2010), who noted that student-centred learning environments encourage greater engagement and self-efficacy among learners.

Theme 2: Engagement Through Real-Life Examples

Many students expressed a strong preference for the use of real-life examples to illustrate scientific principles. They found that connecting lessons to everyday experiences made the content more relatable, accessible, and easier to retain. As one student shared: “*When teachers use examples from everyday life, I understand the topic better and remember it longer.*” This perspective supports prior research indicating the significance of contextualising science education to promote relevance and long-term retention (Wiselby, 2014).

Theme 3: Mixed Reactions to Group Work

Student feedback on group work revealed a diversity of opinions. Majority of students valued the opportunity for collaboration and peer learning, expressing sentiments such as: *“I like group work because we help each other learn.”* This aligns with findings that scientific topics can be appropriately handled by the students and even better understood when they engage in group discussions and group work (Azure, 2018). Also, a few students expressed frustration regarding unequal levels of participation within groups, noting that some members did not contribute effectively: *“Group work can be unfair because some people don’t do anything.”* This suggests the need for structured group roles and accountability measures to ensure equitable participation (Zetrai et al., 2021).

Theme 4: Need for Variety and Balance

While most students appreciated the use of varied instructional strategies, they cautioned against the overuse of any single method, particularly group work. They emphasised the importance of maintaining instructional diversity to sustain interest and motivation. One student remarked: *“It’s good to change things up, but doing group work all the time gets boring.”* This reinforces pedagogical principles advocating for a balanced and adaptive instructional design to accommodate different learning preferences (McCoy, 2010).

Theme 5: Frustration with Instructional Activities

A few students reported experiencing confusion during several classroom activities, performing with different groups together on different occasions. This hindered their engagement and ability to effectively participate in learning tasks. One student explained: *“Sometimes I get involved in one activity and get lost in another activity in*

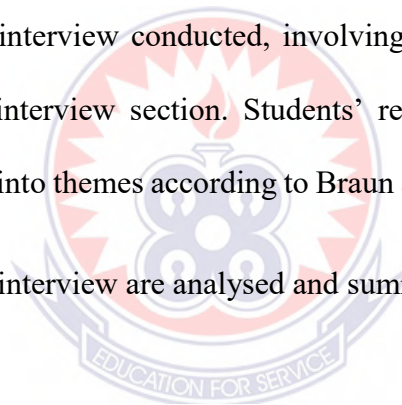
different groupings.” These findings are consistent with research showing that varied instructional strategies improve engagement and learning outcomes when implemented thoughtfully (Zetrai et al., 2021).

Thus, the results suggest that students generally respond positively to active and varied instructional activities in the Integrated Science class, particularly when these are grounded in real-life contexts. The findings suggest that overuse of instructional strategies, such as group work, can lead to student disengagement when not implemented properly during the teaching and learning of Integrated Science.

4.2.2.3 Presentation of Interview Results on Students’ Attitude Towards Science

The unstructured oral interview conducted, involving 10 respondents were assigned number codes in the interview section. Students’ responses were documented and subsequently analysed into themes according to Braun and Clarke’s (2006) framework.

Students’ responses to interview are analysed and summarised in the themes are as follows:



Theme 1: Feelings about Integrated Science Lessons

When asked to describe their feelings about learning the selected concepts in Integrated Science and to give examples of enjoyment or difficulties (Interview Question 1), students expressed a mixture of interest and occasional stress. Most found the interdisciplinary nature of topics like rusting of iron, force, and seed germination engaging. One student noted, *“I feel mostly interested in Integrated Science because it connects different subjects like biology and chemistry, which makes it more meaningful”* (Student 5). However, several students also reported feeling overwhelmed by the volume of content, with one explaining, *“Sometimes, I feel a little stressed when there*

are too many concepts to cover in a short time, but generally, I enjoy it because I like learning about how things work in real life” (Student 8). These responses highlight the emotional complexity of learning Integrated Science and align with Sweller’s (2011) cognitive load theory, which underscores the importance of balancing instructional strategies to sustain learner engagement. Also, students’ appreciation for real-life examples supports Anamuah-Mensah and Mereku’s (2019) advocacy for contextualised science teaching in African classrooms.

Theme 2: Perceived Difficulty or Ease of Concepts

In response to questions about which concepts in Integrated Science students found easy or difficult to understand and why (Interview Question 2), varied perceptions emerged. Concepts such as rusting of iron and force were described as challenging due to their abstract chemical processes and formulas by a few students. One student remarked, *“I find rusting of iron difficult because of the chemical process involved, and force is tricky because of all the formulas”* (Student 1). Most students identified all the concepts as easier to understand. Germination of seeds was often viewed as easier to grasp, attributed to its observable nature. A student noted, *“I find germination easy because we can see it happening with seeds we plant”* (Student 10). Another student added the role of DI, stating, *“Due to practical activities and the way the teacher explains, it makes it easy to understand the force concepts”* (Student 2). Another remarked, *“I do not find any difficulty in learning these topics”* (Student 5). These findings emphasise the critical role of concrete, hands-on experiences and appropriately paced instruction in teaching complex topics in Integrated Science, consistent with

Piaget's (1972) developmental learning theory and Bruner's (1996) constructivist approach advocating for active student engagement in knowledge construction.

Theme 3: Observations of Differentiated Teaching Methods

When asked whether the teacher used different teaching methods for different students and whether students personally experienced varied instructional approaches during lessons on rusting of iron, force, and seed germination (Interview Question 3), most students confirmed noticing differentiated instruction. One student observed, *“The teacher sometimes gives more examples or extra help to students who struggle, like using videos for some and worksheets for others”* (Student 3). Another shared, *“When some students don't understand rusting, the teacher shows a demonstration, while others take notes”* (Student 7). These findings indicate student awareness of varied teaching strategies within the classroom and support Tomlinson's (2014) assertion that differentiated instruction fosters inclusivity and improves learning outcomes by adapting to individual learning needs.

Theme 4: Preferences for Differentiated Instruction versus Uniform Methods

Responding to whether they preferred uniform teaching methods or differentiated approaches based on student needs (Interview Question 4), students overwhelmingly favoured differentiated methods. One student stated, *“I prefer if the teacher uses different methods because not everyone learns the same way. Some learn by doing experiments, others by reading or listening”* (Student 4). Another added, *“Using the same method for everyone makes it hard for those who don't learn well that way”* (Student 9). These responses reflect an understanding of Gardner's (1983) theory of multiple intelligences and underscore the impact of varied instructional strategies, particularly for complex topics like force and rusting of iron. The preference for

differentiated instruction aligns with Tomlinson's (2014) research, emphasising improved learning outcomes when teaching adapts to diverse learner profiles.

Theme 5: Preferred Teaching Strategies

When students were asked about the teaching strategies or activities that helped them learn the concepts in Integrated Science better and what advice they would give their teacher to improve instruction on difficult topics (Interview Question 5), most effective approaches were identified. Practical activities, including hands-on experiments and group work, were especially valued. One student commented, *"I learn better when the teacher uses group work and practical activities like experiments and projects. It makes science more interesting and easier to understand"* (Student 6). Multimedia resources such as videos and images were also highlighted for clarifying difficult concepts, with another student noting, *"Videos and pictures help me understand force and rusting better than just listening"* (Student 2). These findings support Vygotsky's (1978) social constructivist theory, which highlights the significance of active, collaborative, and multimodal learning in science education. Additionally, the preference for hands-on, differentiated, and multimodal teaching methods aligns with Tomlinson's (2014) framework, advocating systematic differentiation to meet diverse learner needs effectively.

Thus, despite the observed use of varied instructional strategies such as hands-on activities, demonstration, flexible grouping, and multimodal instruction, the data indicate that teachers do not consistently employ structured differentiated instructional strategies in the Integrated Science class. Integrating more practical activities and real-life applications could further enhance understanding, especially of abstract concepts in Integrated Science.

4.2.3 Research Question Three: What challenges do teachers face in employing a differentiated instructional approach in the teaching and learning of Integrated Science?

This question aimed to examine the challenges that Integrated Science teachers encounter when implementing differentiated instruction (DI) in the teaching and learning of the concepts in Integrated Science, based on open-ended and closed-ended questionnaires. The responses were analysed using thematic analysis, guided by Braun and Clarke's (2006) framework. Codes were grouped into themes reflecting teachers' common experiences.

4.2.3.1 The quantitative analysis of challenges that teachers encounter when implementing differentiated instruction in teaching concepts in Integrated Science

Table 7 displays the teachers' responses regarding challenges to implementing differentiated instruction. In Table 7, a predominant challenge reported by teachers is the difficulty in developing lesson plans that accommodate the diverse learning needs of students. With respect to Item 1, a significant 80.00% of respondents (40.00% agree; 40.00% strongly agree) identified lesson planning as a considerable obstacle, emphasising the complexity involved in tailoring instruction for varied learner profiles. This result is consistent with studies by Tomlinson and Imbeau (2010) that differentiated instruction (DI) requires teachers to address students' readiness levels, interests, and learning profiles, which demands sophisticated planning and deep pedagogical understanding. This intricacy can pose a substantial barrier, particularly in contexts where curricular demands are rigid and instructional time is limited.

Time constraints (Item 2) emerged as another major hindrance to effective DI implementation, with 80.00% of teachers (53.33% agree; 26.67% strongly agree)

reporting that limited time negatively affects their ability to adapt instruction. Hall (2002) supports this finding by arguing that one of the most significant barriers to differentiation is the lack of time for teachers to assess students' needs, plan responsive instruction, and adjust materials accordingly. Without adequate time for reflection and collaboration, even well-intentioned DI efforts may falter.

Insufficient instructional resources (Item 3) were highlighted by 86.66% of teachers, who disagreed or strongly disagreed with having access to necessary materials to support differentiated instruction. This shortage can severely limit the scope, creativity, and personalisation of DI strategies. Studies by Heacox (2012) assert that resource-rich environments allow for more flexible grouping, tiered assignments, and the use of diverse content delivery methods critical components of effective differentiation. In resource-constrained classrooms, however, the feasibility of implementing such practices is diminished.

Teachers also expressed concerns about increased workload (Item 4), with 80.00% of participants (60.00% agree; 20.00% strongly agree) noting that DI requires substantially more effort compared to traditional teaching methods. This aligns with Tomlinson's (2014) observation that differentiated instruction is not a one-size-fits-all approach; it demands continual assessment, instructional adaptation, and often the creation of multiple lesson versions. Though there are considerable challenges associated with implementing differentiated instruction (DI), a notable proportion of teachers expressed confidence in their ability to apply DI strategies effectively. 33.34% of respondents either agreed (6.67%) or strongly agreed (26.67%) that they felt confident in implementing DI (Item 5) within Integrated Science lessons. However, 40.0% of teachers reported a neutral stance, and 26.67% either disagreed (20.00%) or strongly disagreed (6.67%), indicating a mixed level of self-efficacy across the teaching

cohort. This variability in perceived competence aligns with Hall et al. (2004), that confidence in one's ability to differentiate instruction is a key determinant in whether teachers adopt and sustain such strategies. Teachers with high self-efficacy are more likely to embrace innovative pedagogical practices, such as DI, and are better equipped to handle classroom complexities and learner diversity. In contrast, those with lower self-efficacy may avoid these practices or implement them with less consistency and depth (Tschannen-Moran & Woolfolk Hoy, 2001).

Therefore, while the findings suggest a foundational level of self-efficacy among nearly half of the teachers, they also exhibit the need for capacity-building initiatives to support and expand teachers' confidence in differentiated practices. Effective DI cannot be realised through a teacher's will alone; rather, it requires structured opportunities for collaborative planning, adjustments to instructional time, and enhanced resource allocation (Tomlinson, 2014; Heacox, 2012). Professional development programs that include modelling, coaching, and reflective practice alongside reduced workload and better access to materials can significantly enhance teachers' belief in their ability to implement DI successfully (Tomlinson & Imbeau, 2010). To address the structural barriers, schools can better support teachers in delivering responsive, equitable instruction that meets the diverse needs of all students in Integrated Science classrooms.

Table 7: Teachers' Challenges in Implementing Differentiated Instruction

Challenge Item	Strongly Disagree f (%)	Disagree f (%)	Neutral f (%)	Agree f (%)	Strongly Agree f (%)
1. Developing lesson plans that cater to the diverse learning needs of students is challenging for me.	0 (0.00)	1 (6.67)	2(13.33)	6(40.00)	6(40.00)
2. Effective implementation of differentiated instruction is hindered by limited time.	0 (0.00)	1 (6.67)	2(13.33)	8(53.33)	4(26.67)
3. I have the resources needed to support differentiated instruction in Integrated Science lessons.	5 (33.33)	8 (53.33)	1 (6.67)	1 (6.67)	0 (0)
4. Differentiated instruction significantly increases my workload.	0 (0.00)	1 (6.67)	2(13.33)	9(60.00)	3(20.00)
5. I feel confident in implementing differentiated instructional strategies in Integrated Science sessions.	1 (6.67)	3 (20.00)	(40.00)	1 (6.67)	4(26.67)

f = frequency, % = percentage in paratheses, N = 15

4.2.3.2 Challenges Teachers Encounter When Implementing DI in Integrated Science Lessons: Qualitative Narration from Teachers.

The qualitative analysis of open-ended questionnaires from the teachers in response to Research Question 3.

Question asked: *“What significant challenges do you encounter when implementing differentiated instruction in your Integrated Science lessons?”*

Teachers' responses are analysed and summarised in the themes are as follows;

Theme 1: Meeting Students' Needs is Difficult

Most teachers expressed challenges related to addressing the diverse abilities, learning styles, and individual needs of students within their classrooms. One participant articulated this difficulty, stating, *"My students vary so much in ability that it's difficult to make sure everyone is learning at the right level."* This shows the complexity teachers face when attempting to tailor instruction to accommodate varied readiness levels, interests, and learning profiles.

Findings reflect studies that many teachers report feeling overwhelmed by the scope of diversity and the pedagogical skills necessary to address it adequately (Subban, 2006). This aligns with Gardner's (2011) research, which indicates that the recognition of multiple intelligences and varied learning modalities demonstrates the importance of designing instruction that taps into diverse cognitive strengths and preferences. Dixon et al.'s (2014) study has shown in support of these findings that the practical constraints, such as time, resources, and training, often impede teachers' ability to meet these needs effectively.

Theme 2: Large Class Sizes

The size of the classroom was cited as a major impediment to effective DI implementation. Most teachers expressed that with over 40 students, individual attention and small-group instruction become impractical. As one participant stated, *"It's hard to pay attention to all the students when there are over 40 in the class."* Findings consistent with research that large class sizes limit the feasibility of formative

assessment, classroom management, and flexible grouping, all of which are critical components of DI (Joseph et al., 2013).

Theme 3: Limited Time for Proper Planning and Execution

Time constraints emerged as the most frequently cited obstacle. Most teachers reported that differentiated planning requires significantly more time than is typically available between lessons. One teacher remarked, *“I struggle to plan for different student needs because there just isn’t enough time between lessons.”* Time limitations are consistently identified in the literature as a central barrier to DI (Hall et al., 2004; Dixon et al., 2014). Thus, findings suggest that effective differentiation demands time not only for lesson design but also for student assessment, material preparation, and reflection.

Theme 4: Inadequate Instructional Resources

Several teachers also emphasised the insufficient instructional materials, such as teaching aids, science lab equipment, and digital instruments. As one participant explained, *“We are expected to differentiate, but there aren’t enough resources to support different activities or levels.”* Consistent with Heacox (2012), who said that differentiated classrooms require access to a variety of resources to modify content and delivery methods according to learner needs. The absence of such materials can significantly limit the effectiveness of DI strategies. Findings supported by research indicate that, in science education, where hands-on experimentation and visual aids are essential, insufficient resources directly undermine the quality of instruction (Santangelo & Tomlinson, 2009).

Theme 5: Professional Development Issues

A significant challenge identified by several teachers was the lack of adequate professional development related to differentiated instruction (DI). One teacher candidly shared, *“I know what differentiation is, but I don’t feel confident doing it because I haven’t received enough proper training.”* This statement underscores a critical gap between theoretical understanding and practical application, highlighting how insufficient training can undermine teachers’ confidence and efficacy in implementing DI strategies. Findings consistent with studies, that professional development programs that offer hands-on training, collaborative planning time, and ongoing coaching have been shown to enhance teacher competence and confidence in adapting instruction to meet diverse learner needs (Tomlinson, 2014; Dixon et al., 2014).

Thus, findings align with prior research (Magableh & Abdullah, 2020) that has consistently identified several barriers to the effective implementation of differentiated instruction. Studies by Joseph et al. (2013) identified the most prominent challenges, including time constraints, shortages of instructional resources, overcrowded classrooms, curriculum rigidity, and insufficient professional development opportunities for teachers. Findings align with research reports that development and integration of instructional approaches were perceived as time-consuming, with teachers indicating difficulty in balancing innovative practices with the demands of covering the prescribed curriculum (Smets & Struyven, 2020). Similar challenges were identified by teachers in studies, indicating that a lack of access to essential instructional materials, technological infrastructure, and professional development opportunities is a significant barrier to effective implementation (Zerai et al., 2023).

Thus, teachers face multiple challenges in implementing differentiated instruction in Integrated Science, primarily related to time, resources, class size, and preparedness. The responses suggest that while teachers understand the importance of DI, systemic constraints and lack of support significantly limit their ability to implement it effectively.



CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Overview

This chapter presents a summary of the major findings of the study, draws conclusions based on the results, and provides recommendations for practice, policy, and future research. The study explored the effectiveness of differentiated instruction (DI) on students' academic performance and attitudes in Integrated Science, as well as the challenges teachers face when implementing DI strategies. The chapter begins with a summary of the key findings from both quantitative and qualitative data. It then outlines the main conclusions derived from the research and concludes with evidence-based recommendations aimed at improving the implementation and impact of differentiated instruction in science education.

5.1 Summary of Findings

The study investigated the effect of differentiated instruction on the academic performance of students on 'Selected concepts' in Integrated Science in both Paga SHS and Nabango SHTS. The first question found out the effect of DI on students' academic performance on three selected concepts. The second question investigated students' attitudes towards the use of DI, while the third question also examined teachers' challenges in implementing DI. A hypothesis was tested to examine the effect.

The first null hypothesis (H_{01}) stated that there is no significant difference between the pre-test scores of the experimental and control groups regarding topics such as *corrosion and rusting of metals (rusting of iron), force, and seed germination*. An independent samples t-test was employed to test this hypothesis. The results indicated in Tables 2 and 3 that was not statistically significant at $\alpha = .05$. The p-value exceeded

the significance level and the Cohen's d value went well below the threshold for a small effect. Consequently, the null hypothesis was retained, confirming that both groups were statistically equivalent in their understanding of the selected concepts before the intervention.

The second null hypothesis (H_{02}) proposed that there would be no statistically significant difference in post-test scores between students taught using differentiated instruction (DI) and those taught with traditional methods on the topics of rusting of iron, force, and germination of seed. Both the experimental and control groups received instruction over six weeks, after which a post-test was administered. The experimental group recorded a higher mean score compared to the control group with a huge mean difference. These results, presented in Table 4, initially suggested a potential benefit of DI, but confirmation of statistical significance required further analysis. Table 5 provides the results of an independent samples t -test comparing the post-test scores of both groups. The t -test yielded a statistically significant result. Since the p -value is less than the significance level and with a large effect size, the null hypothesis was rejected. Thus, it was concluded that the difference in post-test performance between the experimental and control groups was statistically significant. The findings indicated that the use of differentiated instruction had a positive effect on student performance in Integrated Science. The significant improvement in the experimental group's scores supports the effectiveness of DI in enhancing students' understanding of the selected scientific concepts.

Findings from the quantitative analysis of students' attitudes toward the differentiated instructional (DI) approach in Integrated Science revealed overwhelmingly positive attitudes among the experimental group. A substantial majority of students reported increased active engagement when a variety of teaching strategies were employed.

Similarly, over half of the students indicated that lessons adapted to different learning styles enhanced their motivation to learn Integrated Science. Again, nearly half of the participants expressed that DI made learning scientific concepts more interesting. When asked to compare instructional methods, most students preferred the differentiated approach over traditional lecture-based teaching. Regarding appreciation of DI, an overwhelming majority of students, responded positively, only expressed disagreement or neutrality. The findings suggested that DI fosters positive attitudes in terms of engagement, motivation, interest, and instructional preference, highlighting its potential effectiveness in addressing diverse learning needs within the Integrated Science classroom.

The qualitative analysis of responses from students in the experimental group revealed five key themes related to their experiences with varied learning activities in Integrated Science. First, students reported that participation in active learning activities such as discussions, experiments, and hands-on tasks boosted their confidence and enhanced their understanding of scientific concepts. Many emphasised that active involvement was more engaging than passive listening. Second, students appreciated the use of real-life examples, noting that these connections made scientific principles more relatable, easier to understand, and memorable. Third, attitudes toward group work were mixed. While some students valued collaboration and peer support, others expressed frustration with unequal participation among group members, indicating the need for clear roles and accountability. Fourth, students stressed the importance of variety and balance in instructional methods, cautioning against the overuse of any single approach, particularly group work, to maintain interest and motivation. Finally, a few students expressed frustration when multiple activities and groupings occurred simultaneously, which hindered their engagement and participation.

The interview findings revealed five major themes regarding students' attitudes toward differentiated instruction in Integrated Science. First, students generally enjoyed Integrated Science, especially its real-life relevance and interdisciplinary nature, although some felt overwhelmed by the volume of content. Second, while some concepts in germination, force, and rusting of iron were considered easy for most students, only a few found them abstract due to the chemical process and formula involved in their observable nature. Third, students recognised that their teachers used differentiated strategies, such as offering demonstrations or using varied materials, which helped address different learning needs. Fourth, most students preferred differentiated instruction over traditional methods, as they believed varied teaching approaches catered better to diverse learning styles. Finally, students favoured practical and collaborative teaching strategies such as experiments, group work, and multimedia resources, which made learning more engaging and understandable. Interviews confirmed that differentiated instruction, when applied effectively, improves engagement and comprehension, especially for complex Integrated Science topics.

Findings from the descriptive statistics of challenges faced by teachers in implementing differentiated instruction (DI) in Integrated Science revealed several significant barriers. Most teachers identified developing lesson plans that address diverse learning needs as a considerable challenge, reflecting the complexity involved in tailoring instruction to varied student profiles. Time constraints were also a major obstacle, majority of teachers agreed that limited instructional time hindered effective DI implementation. Additionally, most teachers reported insufficient access to resources necessary to support DI, which limits the ability to employ varied instructional strategies effectively. Teachers further expressed workload concerns, agreeing that DI substantially increases their teaching responsibilities compared to traditional methods. Despite these

challenges, nearly half of the teachers expressed confidence in their ability to implement DI strategies, though there was notable variability in self-efficacy across the cohort. This mixed level of confidence suggests a need for ongoing professional development and structural support.

Results from the qualitative analysis of teachers' responses revealed five main challenges in implementing differentiated instruction (DI) in Integrated Science. First, teachers reported difficulty in meeting the diverse needs of students, citing challenges in addressing varied abilities, learning styles, and readiness levels. Second, large class sizes, often exceeding 40 students, limited opportunities for individualised attention and flexible grouping. Third, time constraints were frequently noted, with teachers indicating insufficient time for planning and executing differentiated lessons. Fourth, inadequate instructional resources, including teaching aids and laboratory equipment, hindered effective differentiation. Finally, several teachers expressed a lack of sufficient professional development related to DI, which affected their confidence and ability to implement differentiated strategies effectively. These findings highlight significant systemic and practical barriers that limit teachers' capacity to apply DI in Integrated Science classrooms.

5.2 Conclusion

The study found that differentiated instruction (DI) significantly improved students' academic performance in Integrated Science compared to traditional methods. Students responded positively to DI, reporting increased engagement, motivation, and understanding. However, teachers identified several challenges in implementing DI, including limited time, large class sizes, lack of resources, and insufficient professional development. While DI shows strong potential to enhance Integrated Science, its effectiveness depends on addressing these practical and systemic barriers.

5.3 Recommendations

Based on the findings of this study, the following recommendations are proposed to enhance the effective implementation of differentiated instruction (DI) in Integrated Science classrooms:

1. Implement Ongoing and Practical Professional Development for Teachers

Ministries of Education, Ghana Education Service and school administrators should invest in continuous professional development programmes focused specifically on differentiated instruction for integrated science teachers in the Kasena-Nankana West District. These workshops should move beyond theoretical discussions and provide hands-on training, such as lesson design, formative assessment strategies, flexible grouping techniques, and classroom management within differentiated settings. Coaching, peer observation, and follow-up support should be incorporated to reinforce teachers' skills and build confidence in implementing DI effectively in both Paga SHS and Nabango SHTS.

2. Reduce Class Sizes to Support Individualised Instruction

School leaders, in collaboration with GES in the Kasena-Nankana West District, should make efforts to reduce student-to-teacher ratios. Where feasible, efforts should be made to lower student-to-teacher ratios, particularly in Integrated Science classes where hands-on, interactive instruction is essential. Smaller class sizes will allow teachers to better manage diverse learners, provide timely feedback, and facilitate flexible grouping, key components of DI. In cases where reducing class sizes is not possible, schools should consider co-teaching models or assigning teaching assistants to support instruction.

3. Allocate Adequate Time for Lesson Planning

GES and school leaders in Kasena-Nankana West District should revise teaching schedules or workloads to provide teachers with sufficient planning time to design and implement differentiated lessons effectively. Teachers require sufficient time within their work schedules to design and prepare differentiated lessons that meet varied student needs. This can be achieved by reducing non-instructional responsibilities or integrating planning periods into the school day.

4. Ensure Adequate Provision of Instructional Resources

The Ministry of Education should ensure that science departments are better equipped with teaching aids, lab equipment, printed resources, and digital tools to support varied instructional methods and student needs. GES in Kasena-Nankana West District should ensure that schools have functioning science laboratories and sufficient supplies to support hands-on activities and inquiry-based learning in Integrated Science. This is critical, especially in Integrated Science, where practical, visual, and interactive materials help accommodate different learning styles and readiness levels.

5. Support Collaborative Teaching and Learning Communities

Institutions should encourage collaborative planning among teachers through professional learning communities (PLCs) or team-teaching models, which can help share best practices and ease the workload of DI planning. Encourage co-planning and collaboration among teachers in both SHSs to share ideas, resources, and strategies in teaching concepts in Integrated Science.

6. Establish Monitoring and Evaluation Mechanisms

The school administrators should implement systems to regularly monitor the use of DI and evaluate its impact on student learning, allowing for continuous improvement in classrooms. This can include classroom observations, student performance tracking, and teacher self-assessment tools. Data collected should be used to inform decision-making, provide targeted support, and refine teaching practices.

7. Encourage Student Feedback

Teachers in Paga Senior High and Nabango Senior High Technical should implement mechanisms for regularly collecting student feedback on instructional methods used in Integrated Science. Understanding students' preferences, challenges, and perceptions can help teachers refine DI strategies to improve engagement and learning outcomes. Student input should be integrated into instructional planning to ensure that learning activities are both relevant and responsive to their needs.

8. Promote the Use of Real-Life Examples and Hands-On Activities

Integrated Science teachers in both schools should be encouraged to contextualise scientific concepts using real-world applications relevant to students' everyday experiences. Integrate practical experiments, projects, and demonstrations to enhance students' understanding and retention of abstract concepts in Integrated Science.

9. Encourage Instructional Variety and Balance

The Integrated Science teachers in SHSs should avoid over-reliance on any single method, such as group work, by integrating a variety of instructional approaches, including independent tasks, peer tutoring, multimedia tools, and direct instruction where necessary to sustain students' interest and motivation.

10. Develop a Supportive Policy Environment

Education authorities and policymakers should create policies that support the integration of differentiated instruction in curriculum planning and assessment practices. DI practices should be included as part of performance evaluations and school improvement plans.

11. Encourage a Collaborative School Culture

Administrators of schools, together with GES within Kasena-Nankana West District, should foster a culture of shared responsibility among teachers, administrators, and support staff to ensure successful DI implementation. Promote communities of practice where teachers can exchange ideas, reflect on challenges, and celebrate successes.

12. Integrate Differentiated Instruction into Teacher Training Programmes

Teacher education institutions in Ghana should embed differentiated instruction principles and practices into pre-service and in-service training. This will prepare teachers with the necessary skills to plan and implement differentiated lessons effectively from the onset of their careers.

5.4 Suggestions for Further Studies

1. Larger and More Diverse Sample

Future research should involve a larger sample size drawn from multiple schools and districts across the Upper East Region of Ghana. This would help improve the generalisability of the findings to wider populations.

2. Different Students and Programmes

Further studies could investigate the effect of differentiated instruction on other levels in both Senior High Schools and across different programmes, such as Science, Business, Home Economics, to compare variations in effectiveness.

3. Different Subject Areas

Since this study focused on Integrated Science, subsequent research could extend to other subjects such as Mathematics, English Language, or Social Studies to determine whether differentiated instruction yields similar improvements in students' performance.

4. Longitudinal Studies

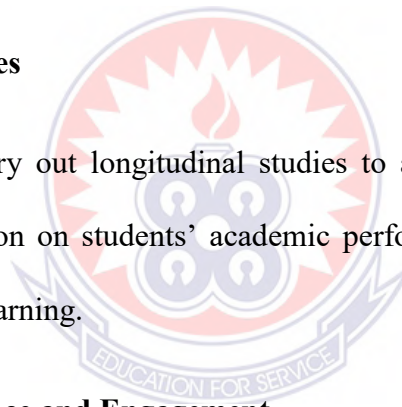
Researchers could carry out longitudinal studies to assess the long-term effects of differentiated instruction on students' academic performance, retention of concepts, and attitudes toward learning.

5. Impact of Attendance and Engagement

Considering the challenge of absenteeism, future research could explore strategies to enhance student participation and examine how consistent attendance affects the outcomes of differentiated instruction.

6. Teacher Preparedness and Training

Another area for future study is examining how teachers' knowledge, training, and attitudes toward differentiated instruction influence its effectiveness in classroom settings.



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APPENDICES

APPENDIX A

PRE-TEST BEFORE TREATMENT

MULTIPLE CHOICE QUESTIONS

Instructions

DATE

DURATION: 60 minutes

The test is made up of thirty (30) objective questions. Answer all the questions.

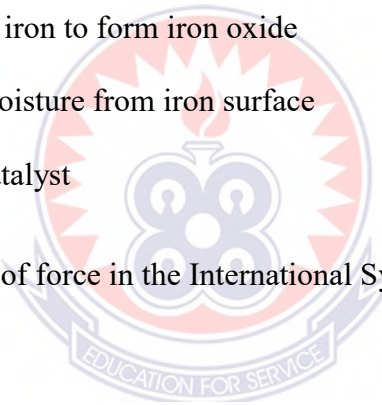
Please circle the correct answer from the options (A-D).

1. What is the primary reason why stainless steel is resistant to rusting?
 - A) It contains no iron
 - B) It has a high carbon content
 - C) It contains chromium, which forms a protective oxide layer
 - D) It is coated with paint
2. What is rusting?
 - A) The corrosion of iron in the presence of moisture and oxygen
 - B) The process of metal melting
 - C) The oxidation of aluminium
 - D) The formation of a protective layer on metals
3. Which chemical compound is primarily formed during the rusting of iron?
 - A) Iron oxide (FeO)
 - B) Iron sulphate (FeSO₄)
 - C) Iron (III) oxide (Fe₂O₃·nH₂O)
 - D) Iron chloride (FeCl₃)

4. Which of the following conditions accelerates the rusting process?
 - A) Dry air
 - B) High humidity and saltwater exposure
 - C) Cold temperatures
 - D) Protective coatings
5. What is one common method used to prevent rusting in iron?
 - A) Exposing it to sunlight
 - B) Keeping it in a dry environment only
 - C) Submerging it in oil
 - D) Painting or applying a protective coating
6. Which of the following metals is often used to galvanize iron to prevent rusting?
 - A) Zinc
 - B) Copper
 - C) Lead
 - D) Aluminium
7. What role does oxygen play in the rusting process?
 - A) It prevents rusting
 - B) It acts as a catalyst for rusting
 - C) It combines with iron to form rust
 - D) It does not affect rusting
8. Which of the following is NOT a factor that contributes to rusting?
 - A) Presence of water
 - B) Presence of acids



- C) High humidity
- D) Vacuum conditions
9. What is the term for the protective layer that can form on some metals, preventing further corrosion?
- A) Patina
- B) Oxide layer
- C) Corrosion barrier
- D) Rust
10. What role does oxygen play in the rusting of iron?
- A) It prevents rusting
- B) It reacts with iron to form iron oxide
- C) It removes moisture from iron surface
- D) It acts as a catalyst
11. What is the unit of force in the International System of Units (SI)?
- A) Joule
- B) Newton
- C) Pascal
- D) Watt
12. Which of the following best describes force?
- A) The mass of an object
- B) The speed of an object
- C) A push or pull on an object
- D) The energy of an object
13. What is the formula for calculating force?
- A) $F = m + a$



B) $F = m / a$

C) $F = m \times a$

D) $F = m - a$

14. If an object has a mass of 10 kg and is accelerating at 2 m/s^2 , what is the force acting on it?

A) 5 N

B) 10 N

C) 20 N

D) 30 N

15. Which of the following forces is a contact force?

A) Gravitational Force

B) Magnetic Force

C) Electrostatic Force

D) Frictional Force

16. What type of force opposes the motion of an object sliding on a surface?

A) Gravitational Force

B) Frictional Force

C) Normal Force

D) Tension Force

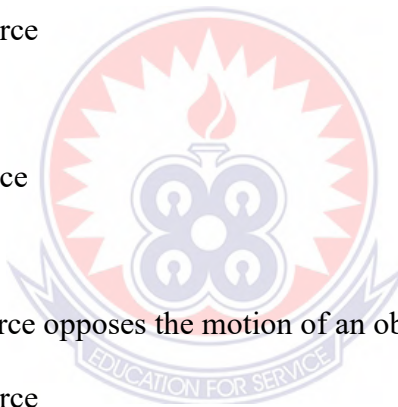
17. Which of the following is a non-contact force?

A) Frictional force

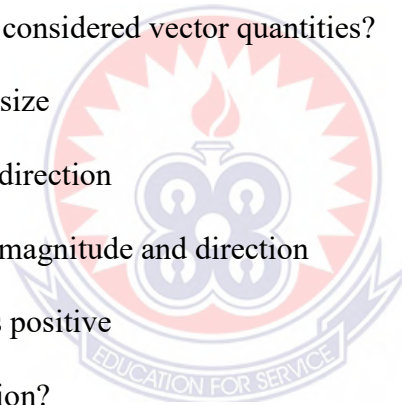
B) Tension force

C) Magnetic force

D) Normal force



18. What is the effect of balanced forces on an object?
- A) It accelerates in the direction of the net force
 - B) It remains at rest or continues moving at constant velocity
 - C) It experiences a change in shape
 - D) It falls to the ground
19. What is the force called that pulls objects toward the centre of the Earth?
- A) Tension
 - B) Friction
 - C) Gravity
 - D) Normal force
20. Why are forces considered vector quantities?
- A) They only have size
 - B) They only have direction
 - C) They have both magnitude and direction
 - D) They are always positive
21. What is germination?
- A) The process of seed dispersal
 - B) The process by which a seed develops into a new plant
 - C) The process of photosynthesis
 - D) The process of pollination
22. In which type of germination does cotyledons emerge above the soil?
- A) Hypogeal germination
 - B) Epigeal germination
 - C) Dormant germination
 - D) Asexual germination



23. What is the primary purpose of water in the germination process?

- A) To provide nutrients
- B) To provide light for photosynthesis
- C) To activate enzymes and facilitate metabolic processes
- D) To support the seed physically

24. Which type of seed germinates faster under optimal conditions?

- A) Dormant seeds
- B) Viable seeds
- C) Non-viable seeds
- D) Dehydrated seeds

25. What is the main function of the radicle during germination?

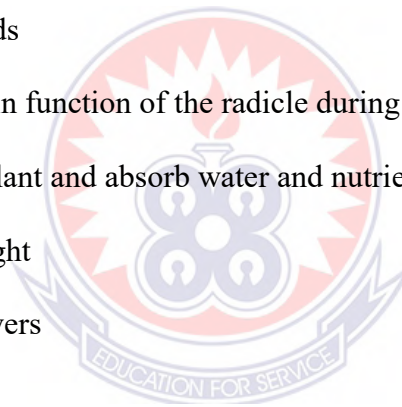
- A) To anchor the plant and absorb water and nutrients from the soil
- B) To absorb sunlight
- C) To produce flowers
- D) To store energy

26. Which of the following factors can inhibit seed germination?

- A) Excessive moisture
- B) Low temperatures
- C) Lack of oxygen
- D) All of the above

27. What role does water play in the germination process?

- A) It provides nutrients to the seed.
- B) It activates enzymes and softens the seed coat.



C) It prevents the seed from rotting.

D) It provides structural support to the seedling.

28. Which temperature range is generally considered optimal for most seeds to germinate?

A) 20-30°C

B) 0-10°C

C) 40-50°C

D) 60-70°C

29. What is the testa in a seed?

A) The embryo of the seed

B) The nutrient storage area

C) The outer protective layer

D) The root system of the seedling

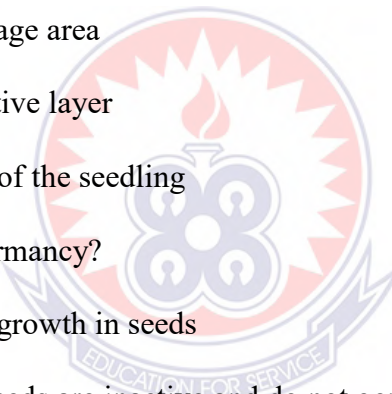
30. What is seed dormancy?

A) A stage of rapid growth in seeds

B) A period when seeds are inactive and do not germinate

C) A phase where seeds absorb nutrients from the soil

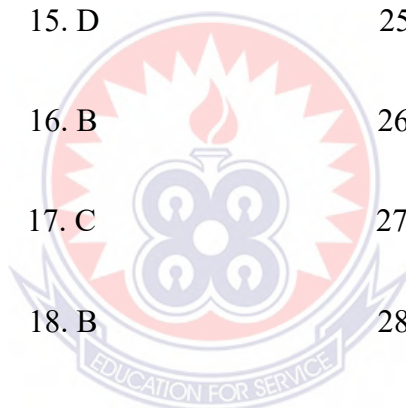
D) A condition where seeds are permanently dead



APPENDIX B
PRE-TEST MARKING SCHEME

30 marks (1 mark each)

1. C	11. B	21. B
2. A	12. C	22. B
3. C	13. C	23. C
4. B	14. C	24. B
5. D	15. D	25. A
6. A	16. B	26. D
7. C	17. C	27. B
8. D	18. B	28. A
9. A	19. C	29. C
10. A	20. C	30. B



APPENDIX C

POST- TEST AFTER TREATMENT

MULTIPLE CHOICE QUESTIONS

Instructions

DURATION: 60 minutes

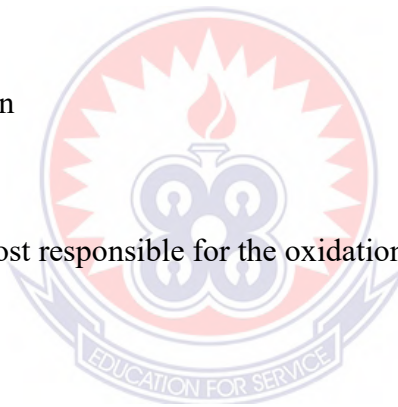
DATE

The test is made up of thirty (30) objective questions. Answer all the questions.

Please circle the correct answer from the options (A-D). One mark for each question

1. What is the main disadvantage of rusting?
 - A) It strengthens the metal
 - B) It increases the weight of the metal
 - C) It weakens and deteriorates the metal over time
 - D) It improves conductivity
2. Which chemical compound is primarily formed during the rusting of iron?
 - A) Iron oxide (FeO)
 - B) Iron sulphate (FeSO_4)
 - C) Iron chloride (FeCl_3)
 - D) Iron (III) oxide ($\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$)
3. Which of the following is essential for rusting of iron?
 - A) Only oxygen
 - B) Only water
 - C) Both oxygen and water
 - D) Neither oxygen nor water
4. Which of the following methods helps prevent rusting of iron?
 - A) Keeping iron in a humid place
 - B) Coating iron with paint or oil

- C) Exposing iron to both air and water
- D) Using pure iron without any coating
5. Which of the following metals is often used to galvanize iron to prevent rusting?
- A) Zinc
- B) Copper
- C) Lead
- D) Aluminium
6. What is the process of coating iron with a layer of zinc called?
- A) Electroplating
- B) Painting
- C) Galvanization
- D) Anodizing
7. Which gas is most responsible for the oxidation of iron during rusting?
- A) Nitrogen
- B) Hydrogen
- C) Oxygen
- D) Carbon dioxide
8. Why does saltwater speed up the rusting process?
- A) It blocks oxygen from reaching the iron
- B) It increases the conductivity of water, enhancing electrochemical reactions
- C) It prevents moisture from forming
- D) It evaporates quickly
9. Which of the following is a chemical method of preventing rust?
- A) Applying a plastic coating



- B) Keeping metal indoors
- C) Using anti-rust sprays or inhibitors
- D) Drying the metal with a cloth
10. What happens to iron atoms during the rusting process?
- A) They gain electrons
- B) They lose electrons and form iron ions
- C) They remain unchanged
- D) They become heavier
11. An object will float in a fluid if:
- A) Its density is greater than the fluid.
- B) Its weight is greater than the buoyant force.
- C) The buoyant force is equal to its weight.
- D) It is hollow.
12. What is the force called that pulls objects toward the centre of the Earth?
- A) Tension
- B) Friction
- C) Gravity
- D) Normal force
13. Which of the following best explains Archimedes' Principle?
- A) A body immersed in water always sinks unless supported.
- B) A floating object displaces its weight in water.
- C) An object immersed in a fluid experience an upward force equal to the weight of the fluid displaced.
- D) The weight of an object increases in water due to pressure.

14. Which force keeps planets in orbit around the Sun?
- A) Frictional Force
 - B) Gravitational Force
 - C) Electromagnetic Force
 - D) Nuclear Force
15. What instrument is commonly used to measure force?
- A) Thermometer
 - B) Barometer
 - C) Spring balance
 - D) Stopwatch
16. When a body is fully immersed in a liquid, its apparent weight is less than its actual weight. This is due to:
- A) Increase in mass
 - B) Surface tension
 - C) Buoyant force acting upward
 - D) Viscosity of the fluid
17. What is the gravitational force acting on a 3.5 kg object near the Earth's surface? (Use $g = 9.8 \text{ m/s}^2$)
- A) 34.3 N
 - B) 13.6 N
 - C) 9.8 N
 - D) 98 N
18. A 12 kg object experiences a downward force of 86.6 N due to gravity. What is the acceleration due to gravity (g) at that location?
- A) 9.8 m/s^2

B) 74.6 m/s^2

C) 98.6 m/s^2

D) 7.2 m/s^2

19. Which type of force is responsible for changing the shape of an object?

A) Gravitational force

B) Magnetic force

C) Applied force

D) Buoyant force

20. Which force acts upward and balance the weight of an object placed on a surface?

A) Frictional force

B) Normal force

C) Tension force

D) Magnetic force

21. What is the main function of the radicle during germination?

A) To anchor the plant and absorb water and nutrients from the soil

B) To absorb sunlight

C) To produce flowers

D) To store energy

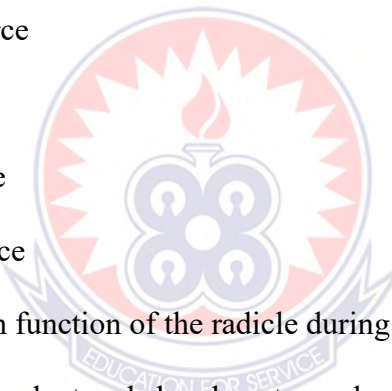
22. What role does water play in the germination process?

A) It provides nutrients to the seed.

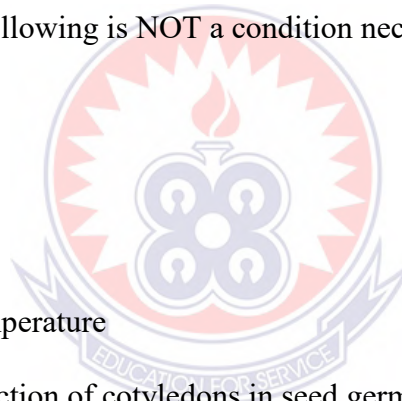
B) It activates enzymes and softens the seed coat.

C) It prevents the seed from rotting.

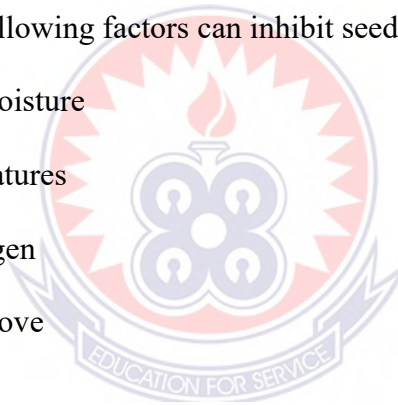
D) It provides structural support for the seedling.



23. What part of the seed develops into the shoot system of the plant?
- A) Radicle
 - B) Plumule
 - C) Cotyledon
 - D) Testa
24. Why is oxygen important during germination?
- A) It keeps the seed moist
 - B) It prevents fungal growth
 - C) It is required for cellular respiration to release energy
 - D) It helps in absorbing sunlight
25. Which of the following is NOT a condition necessary for seed germination?
- A) Water
 - B) Oxygen
 - C) Sunlight
 - D) Suitable temperature
26. What is the function of cotyledons in seed germination?
- A) To protect the embryo
 - B) To perform photosynthesis
 - C) To provide stored food for the growing embryo
 - D) To absorb water from the soil
27. What happens to the seed coat during germination?
- A) It breaks open to allow the embryo to emerge
 - B) It helps the seed photosynthesize
 - C) It hardens to protect the seed
 - D) It transforms into a leaf



28. Which type of seed germinates faster under optimal conditions?
- A) Dormant seeds
 - B) Viable seeds
 - C) Non-viable seeds
 - D) Dehydrated seeds
29. What is the primary purpose of water in the germination process?
- A) To provide nutrients
 - B) To provide light for photosynthesis
 - C) To activate enzymes and facilitate metabolic processes
 - D) To support the seed physically
30. Which of the following factors can inhibit seed germination?
- A) Excessive moisture
 - B) Low temperatures
 - C) Lack of oxygen
 - D) All of the above

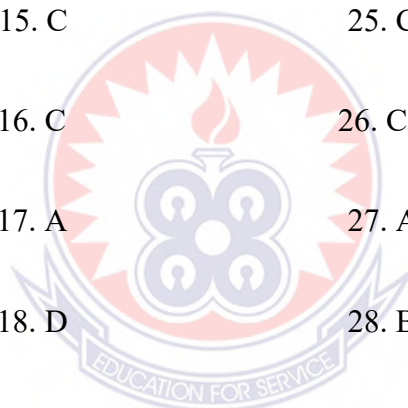


APPENDIX D

POST-TEST MARKING SCHEME

30 marks (1 mark each)

1. C	11. C	21. A
2. D	12. C	22. B
3. C	13. C	23. B
4. B	14. B	24. C
5. A	15. C	25. C
6. C	16. C	26. C
7. C	17. A	27. A
8. B	18. D	28. B
9. C	19. C	29. C
10. B	20. B	30. D



APPENDIX E

INTERVIEW GUIDE

Introduction

Hello, thank you for agreeing to participate in this study. The purpose of this interview is to understand your thoughts and experiences by learning the selected concepts in Integrated Science and how teacher uses different teaching strategies in your class. There are no right or wrong answers; I am only interested in your opinions and experiences. Everything you share will remain confidential, and your name will not appear in any report. You can skip any question or stop the interview at any time.

Do you have any questions before we begin? May I have your permission to proceed with the interview and record our conversation for accuracy?

INTERVIEW QUESTIONS

To start with, I would like to know about your general feelings toward Integrated Science.

1. Can you describe how you feel about learning the selected concepts in your Integrated Science lessons? *Can you give an example of a time when you enjoyed or didn't enjoy learning a particular topic?*

2. *Are there any concepts, such as rusting of iron, force, and seed germination in the Integrated Science lesson that you find particularly easy or difficult to understand? Why?*

Now I would like to hear about the ways teacher teaches the concepts in integrated science.

3. Have you noticed your teacher using different teaching methods for different students in your class when learning concepts such as corrosion and rusting of metals, force, and germination of seed? *Have you personally experienced being taught in a way that felt different from how others were taught in the same lesson? How did you feel about that experience? Can you describe it?*

4. *Would you prefer your teacher to use the same method for everyone or different methods depending on students' needs? Why? Or do you think it is fair for teachers to use different teaching methods for different students? Why or why not?*

Finally, I would like to hear your suggestions.

5. What kind of teaching strategies or activities help you learn Integrated Science concepts better? *If you could advise your science teacher on how to teach difficult topics, what would you suggest? In your opinion, how could Integrated Science lessons be improved to help all students understand better?*

Thank you for sharing your experiences and thoughts. Your responses will help me understand students' views on learning the concepts in Integrated Science and the use of different teaching strategies



APPENDIX F

QUESTIONNAIRE FOR STUDENTS

TITLE: Differentiated Instructional Strategies in Integrated Science: Students'

Attitudes

Dear Participant, this questionnaire is intended to collect data for a study on differentiated instructional strategies for teaching 'selected concepts' in Integrated Science. Your responses are valuable and will be kept confidential. Please respond honestly. There are no correct or wrong answers.

Thank you for your participation.

Section A: Demographic Information

Kindly tick [✓] or fill in the appropriate responses

1. Gender:

Male

Female

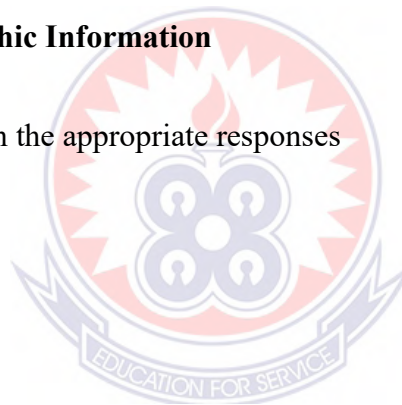
2. Age:

Below 15 years

15-17 years

18 years and above

More than 10 years



Section B: Students' Attitudes Towards Differentiated Learning Approach

(Please this section is for students only)

Instruction: Please tick the response that best reflects your opinion.

SN	STATEMENT	5	4	3	2	1
3	When the teacher implements a variety of teaching strategies in class, I become more actively engaged.					
4	I am more motivated to learn Integrated Science when lessons are modified to diverse learning styles.					
5	Differentiated instruction makes learning concepts in Integrated Science more interesting.					
6	I prefer traditional lecture methods over differentiated instruction options.					
7	I appreciate differentiated instruction when used in teaching and learning process in class.					

8. What do you like or dislike about using various learning activities when studying Integrated Science?

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APPENDIX G

QUESTIONNAIRE FOR TEACHERS

TITLE: The Use of Differentiated Instructional Strategies in Integrated Science: Teachers' Challenges in Implementation

Dear participant, this questionnaire is intended to collect data for a study on differentiated instructional strategies for teaching concepts in Integrated Science. Your responses are valuable and will be kept confidential. Please respond honestly. Thank you for your participation.

Please For Integrated Science Teachers Only

Section A: Demographic Information

Kindly tick [] or fill in the appropriate responses

1. Gender:

Male

Female

2. Age:

Below 20 years

20-30 years

40-50 years

30-40 years

50-60 years

3. Years of experience in teaching.

Less than 2 years

6-10 years

2-5 years

More than 10 years

Section B: Challenges Teachers Encounter in Implementing Differentiated

Instruction

Instruction: Please tick the response that best reflects your opinion.

SN	STATEMENT	5	4	3	2	1
4	Developing lesson plans that meet the various learning needs of students is difficult for me.					
5	Effective implementation of differentiated instruction is hindered by limited time.					
6	I have the resources needed to support differentiated instruction in Integrated Science lessons.					
7	Differentiated instruction significantly increases my workload.					
8	I feel confident in implementing differentiated instructional strategies in Integrated Science sessions.					

9. What significant challenges do you encounter when implementing different instructional strategies in your Integrated Science lessons?

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