THE EFFECTIVENESS OF USING DIFFERENTIATED INSTRUCTION ON SCIENCE LEARNING ACHIEVEMENT FOR GRADE 5 BHUTANESE STUDENTS

BY

CHIMI SELDEN

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Asst.Prof. Athip Thumvichit, Ph.D.
Examination Committee Chairperson

Techameth Pianchana, Ph.D.
Member

Asst.Prof. Nipaporn Sakulwongs, Ed.D.
Member and Advisor

Approved by Graduate School

(Prof. Suejit Pechprasarn, Ph.D.)
Dean of Graduate School
November 25, 2024

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Chimi Selden

Researcher

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Abstract

The purposes of the study were to examine the effectiveness of using differentiated instruction on Science learning achievement and to investigate learning satisfaction of grade 5 Bhutanese Students. This mixed- method research adopted a cluster random sampling method to select a sample group consisting of 30 students from one of the primary schools in Bhutan. The study used pre-test and post-test method to collect quantitative data and semi-structured interview to collect qualitative data. The pretest and posttest were conducted before and after the treatment to find out the level of students' learning achievement. The semi-structured interview was administered after the post-test to find out the students' learning satisfaction in Science.

The result of learning achievement was analyzed using a paired sample t-test. It was found that the post-test mean score (14.37) was higher than the pre-test mean score (8.58) with the mean difference of 5.79. Further, the significance (p) value was 0.01 which indicated using differentiated instruction on Science learning was effective. Additionally, the findings from semi-structured interview concluded that the participants expressed a high level of learning satisfaction. Therefore, differentiated instruction approach should be applied and implemented in schools as it creates new and diverse learning environments to accommodate students' diverse learning requirements, irrespective of their academic status or standing in society.

(Total 128 pages)

Keywords: Differentiated Instruction, Learning Achievement, Learning Satisfaction, Science

Student's Signature …..... Thesis Advisor's Signature .....

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

LIST OF TABLES

Page

Tables

LIST OF FIGURES

Page

Figures

ABBREVIATIONS

Abbreviations	Meaning
STEM	Science, Technology, Engineering and Mathematic
NSB	National Statistical Bureau
MoE	Ministry of Education
NAPE	New Approach to Primary Education
REC	Royal Education Council
TVET	Technical and Vocational Education and Training
GNH	Gross National Happiness
PISA-D	The Program for International Student Assessment Development
BCSEA	Bhutan Council for School Examination and Assessment
OECD	Organization for Economic Co-operation and Development
BHSEC	Bhutan Higher Secondary Education Certificate
BPST	Bhutan Professional Standards for Teachers
BB	Bhutan Baccalaureate
CTAB	Curriculum and Technical Advisory Board
DI	Differentiated Instruction
DCPD	Department of Curriculum and Professional Development
NOS	Nature of Science
NOSK	Nature of Scientific Knowledge
ICT	Information, Communication and Technology
IDEA	Individuals with Disabilities Education Act
MKO	More Knowledgeable Others
ZPD	Zone of Proximal Development
IOC	Item Objective Congruence

CHAPTER 1

INTRODUCTION

This chapter presents the background and rationale of the study, research objectives, research questions, research hypothesis, scope of the study, limitations of the study, expected outcomes followed by operational definitions.

1.1 Background and Rationale of The Study

Science plays an important role in various aspects of our lives, encompassing political, social, and economic realms, evident in technological wonders and the influence of principles and philosophical beliefs (Khishfe, 2012). In an era dominated by technological progress and scientific achievements, the importance of science education and literacy cannot be emphasized enough. Science education is fundamental in nurturing an enlightened and involved citizenry capable of navigating the intricacies of the contemporary world. The ability to comprehend, interpret, and apply scientific knowledge, known as science literacy, is crucial for making well-informed decisions, participating in civic discussions, and contributing to the socio-economic advancement of nations (Vijayatheepan, 2023).

Science education is important in the 21st century and the growing emphasis on Science, Technology, Engineering and Mathematics education is at the forefront of discussion regarding education in the present. Science education can offer a rich context for developing many 21st century skills such as critical thinking, problem solving, and information literacy. It also gives students the opportunity to gain better knowledge on how and why things function. Science can teach children about the world that surrounds them (Singh, 2021). Thereby, the essence of science education and literacy lies at the heart of societal progress and individual empowerment. This is

because, it equips individuals with the tools needed to engage meaningfully in an increasingly complex and interconnected global community (Vijayatheepan, 2023).

Bhutan is a small and landlocked country, situated between China (Tibet) and India. It has an area of 38,394 square kilometers. It has east-west dimension (longest) stretching around 300 kilometers and 170 kilometers at its maximum north-south dimension. Bhutan is located in the eastern Himalayas and is mostly mountainous and heavily forested. It has a population of 770,276 (National Statistical Bureau (NSB), 2023). According to Bhutan Education Blueprint 2014-2024 developed by the Ministry of Education (MoE, 2014), it is mentioned that Bhutan has placed much emphasis on education and it has played a central role in the social, economic, political, cultural, intellectual and environmental development of the country to give it a distinct identity as a small, peaceful, progressive and happy nation. Thereby, the Royal Government of Bhutan continues to accord high importance to education as an engine of growth in the nation building process.

According to NSB (2023), The modern education system in Bhutan was introduced with the initiation of economic development plans in 1961. The education system today has three main forms: General education, Monastic education, and non-formal education. Monastic education was the only form of learning till the 1950s and continues to date. There exists now an extensive network of schools and other educational institutions spread throughout the country. Many schools also provide boarding facilities for students living in areas far from the school with meals provided by the Government.

Owing to the importance of Science in the world at large, Bhutan has also emphasized on the importance of science education. Science Education is considered important in Bhutan to create a scientifically knowledgeable and skillful society to facilitate its socio-economic development (Rabgay, 2021). Science education in Bhutanese schools is provided from upper primary to grade twelve through various subjects: General Science for grades Four to Six, and Integrated Science for grades

Seven and Eight. Students from grades Nine to Twelve learn four subjects, which are Physics, Biology, Chemistry, and Environmental Science.

Historically, Bhutanese science education started with a curriculum borrowed from India but it was later localized to suit the Bhutanese needs. Science education has been accorded great importance ever since modern education was instituted in the country. And to this end, Johnson et al., 2008; Tshewang, 2016 are cited by Dorji, Jatsho, and Choden (2022, p. 2) saying that in 1986, the Royal Government of Bhutan (RGoB) replaced foreign borrowed primary science curriculum by implementing a localized curriculum founded upon the principles of the New Approach to Primary Education (NAPE). The intended purpose for the localized science curricula was to promote the art of scientific inquiry through Bhutan's social and environmental context.

After more than a decade of implementation, the localized primary science curriculum became a hotspot of public scrutiny and debate. Bhutanese from various social strata argued that the localized primary science curriculum was not only shallow in content but also contained outdated learning activities (Royal Education Council [REC], 2022). Therefore, the localized primary science curriculum was revised in 2001 mainly to add appropriate content to enhance quality learning (REC, 2012).

Bhutanese science curriculum witnessed several rounds of reforms to improve the quality of science education (Dorji et al., 2022). The Bhutan Education Blueprint 2014-2024 made suggestions that curricula reforms in STEM, and Technical and Vocational Education and Training (TVET) subjects to be up-scaled; along with the revamping of Social Sciences with the inclusion of the elements of Bhutanese values of Gross National Happiness (GNH) along with 21st century skills and pedagogies (Dukpa, 2016). Gross National Happiness (GNH) is the guiding philosophy of the Royal Government of Bhutan and education in Bhutan is viewed as one of the fundamental ways to achieve GNH (Gyamtso & Maxwell, 2012). The Educating for Gross National Happiness program focuses on the infusion of GNH values in the

curriculum while also emphasizing on providing inclusive education that ensures equitable educational opportunities to all (REC, 2019).

However, despite several rounds of curriculum reforms and revisions, several national and international studies in the past decade continue to point to the need to raise the quality of teaching and student learning in science education. There are numerous reports such as Education in Bhutan: findings from Bhutan's experience in PISA for Development (Bhutan Council of School Examination and Assessment (BCSEA, 2019), citing that Bhutan lagged significantly behind that of OECD (Organization for Economic Co-operation and Development) countries and of the best education systems in Asia. The finding revealed that the average solution rate in Bhutan for scientific literacy was 45.1 percent, which was significantly below the OECD average (BCSEA, 2019). In line to that, National School Curriculum conference 2016: Rethinking Curriculum Report (Royal Education council [REC], 2016) has also indicated that the education content structure in STEM subjects is not inclusive. Similarly, as per the result of Bhutan Higher Secondary Education Certificate (BHSEC) examination 2023, Katel (2024) reported the stream-wise pass percentage. The pass percentage for the Science stream was 82.71 percent, which was comparatively lower in comparison to other streams like Commerce and Arts streams.

Additionally, going by the study findings of the REC (2019), though Science and Mathematics are the integral components of STEM, however the academic achievement disparities between Bhutanese students have shown that the majority of Bhutanese students fall short of the minimum educational standard in all subjects with major disparities in science and mathematics. The study also ascertained that both the Science and Mathematics curriculum were said to be prescriptive and rigid, with significantly more content than the period allocated to teaching, examination driven and less connections to real life situations. Ultimately, the lower ability learners were overstretched while high ability ones were under-utilized. Therefore, the need for developing differentiated curriculum to cater to different ability and interest of students were highly recommended by Royal Education Council (REC, 2016).

The MoE (2014) has also identified teachers' ineffective teaching practice as a cause of students' low academic performances. There has been a persistent need to improve the quality of science education as indicated by the low quality of students learning and teaching reported in several studies. In studies done by Utha et al. (2016) have shown that teaching practices were mostly dominated, with teachers playing the conventional role of knowledge disseminator, teacher-centeredness and teacher's control are used as the main instruments for managing the learning process. As Bhutanese classrooms are also growing culturally and academically diverse like any other country, there are learners that come from different social background with different interest, learning styles, learning profile and abilities. In a classroom of 25 to 35 students, teacher use same method, teaching strategies and content to teach all the children. To this end, Rabgay's (2018) finding reported that teacher talk (85.23%) was much more than students' talk time (11.38 %) which indicated that classroom interaction was dominated by science teachers and interactive teaching environments were hardly ever created.

Due to the need for a better way of teaching science, the MoE placed a great emphasis on education quality. In order to fulfill the vision, the MoE spearheaded the development of a number of education-related documents, including Educating for Gross National Happiness (GNH), Bhutan Education Blueprint 2014-2024, Draft National Education Policy 2019, Bhutan Professional Standards for Teachers (BPST) and Bhutan Baccalaureate (BB). The Bhutan Education Blueprint 2014-2024, Draft National Education Policy 2019 and BPST firmly suggest offering various potential paths for learners. The BPST has seven standards. The first standard is the diversity of learners, anticipating that teachers implement instructional strategies responsive to diverse learners in the classroom (Kado, Doji, Dem, & Om, 2021).

Similarly, as per the Bhutan Baccalaureate (BB) developed in 2021, it emphasizes on nine attributes of school excellence. The first attribute is the individualism, stating that school should nurture the individualism of each student - their particular talents, capabilities, and qualities - making space for their unique path of growth and helping each student acquire the skills to continue growing

autonomously after graduation. To achieve this, while in school, students should practice self-determination and choose their own path of development, and the school must support differentiation and nurture diversity within the student body.

Given the persistent need to raise the quality of teaching in science education, the Government continues to implement measures to support teachers to improve their teaching quality. To this end, the Government plans to strengthen the curriculum for STEM subjects. A recent move has been the development of a differentiated science curriculum to move away from the 'one-size-fits-all' curriculum to enable students to study subjects of their choice based on their aptitude and interest (REC, 2019). Curriculum choices irrespective of disciplines will provide learners an option to focus more in the subjects of their interest. This will also help in taking on-board the learners with different aptitudes and dispel the traditional education belief of assuming every learner to be the same. In this light, the National Education Conference (Sherig Conference) 2017 endorsed the idea of differentiated curriculum. The institutionalization of differentiated curriculum was further discussed, the needs identified to be introduced and deliberated in the 2nd and 3rd Curriculum and Technical Advisory Board (CTAB) meeting. Hence, upon the completion of the needs assessment, National Education conference 2018 and CTAB endorsed the implementation of differentiated curriculum in Mathematics and Science from 2021 academic year (REC, 2019).

Owing to the endorsement of differentiated curriculum, thus, the need for using differentiated instruction also emerged. Abutayeh (2022) asserts that differentiated instruction helps achieving goals, in addition to its role in promoting the sense of justice and equality between students which contributes to building the environment of equity in the society. Therefore, the use of the inclusive instructional practice of differentiated instruction has become even more necessary over time as educators have sought to respond to the continuously increasing student diversity (Scarparolo & Subban 2023).

A classroom is endowed with diversity in learning, thereby, keeping students in one basket, that too, through one stream is a false promise of equity. Each student

comes to the class with differing interests, styles, abilities, and choices (REC, 2019). Despite the diverse learners need in the classroom, it is believed that most Bhutanese science teachers base their lessons on direct instruction. Therefore, the researcher feels that using Differentiated Instruction (DI) is one of the effective strategies to move away from the conventional style of teaching lessons and to solve the stated problems. Though using differentiated instruction has its own threats like affecting student's morality and widening achievement gaps between high ability and low ability groups, however numerous research has also showed the positive findings. As the DI is based on the concept of multiple intelligence, Vygotsky's sociocultural theory of learning and brain-compatible research, it can be very successful in improving learning achievement and learning satisfaction of students. It enables maximum student growth and individual success by providing content learning that is apt to leaners' intellectual level thereby reducing failures.

As a teacher, it is morally and professionally unethical to consider that all students learn in the same way (Kado et al., 2021). Classrooms are currently filled with students who have enormous differences in their readiness, interests, cultural backgrounds, prior knowledge, and learning profiles. Looking at a typical classroom and the ability levels within it, one can conclude that teachers who do not differentiate teach only a fraction of their students (Koeze, 2007). In this regard, teaching science is characterized by the existence of many opportunities in implementing differentiated instruction due to the variety of cognitive content and learning activities, in addition to the various learning environments, such as the classroom, the laboratory and outdoors garden (Abutayeh, 2022). In light of these findings, the researcher had used differentiated instruction as a teaching approach where learners got opportunity to learn lesson as per their interest, readiness, and learning styles.

According to Tomlinson (2001), the founder of the concept differentiated instruction (DI) said, differentiated instruction (DI) is a proactive whereby the teacher assumes different learners with differing needs and plans a variety of ways to "get at" and express learning. Differentiation typically includes pro-active and deliberate adaptations of the content, process, product, learning environment or learning time,

based on the assessment of students' readiness or another relevant student characteristic such as learning preference or interest. To differentiate instruction is to acknowledge various students' backgrounds, readiness levels, languages, interests and learning profiles (Subban,2006). It is a classroom teaching approach consisting of planned adaptations in process, learning time, content, product or learning environment for groups of students or individual students. Adaptations can be based on achievement or readiness or another relevant student characteristic (such as prior knowledge, learning preferences, and interest) with the goal of meeting students' learning needs (Jacobse, Meijer, Helms-Lorenz, & Maulana, 2019).

Magableh and Abdullah (2020), also defined differentiated instruction (DI) as a pedagogical theory founded on the concept of meeting the needs of academically diverse learners according to their readiness levels, interests, and learning profiles. It is a pedagogical-didactical approach that provides teachers with a starting point for meeting students' diverse learning needs (Jacobs et al., 2019). Student diversity includes cognitive, behavioral and affective needs and each of these domains are integral parts and influencing factors on student engagement, motivation, commitment to task and academic success. Therefore, an important and integral part of DI is dependent on how well teachers know their students, including their readiness (or capability, prior knowledge and skills for upcoming content), passions, interests and motivations (Scarparolo & Subban, 2023).

According to Toledo (2023), instruction ought to be differentiated to benefit every individual student since students learn in more ways than one, which additionally affects student engagement and motivation. The researcher believed that use of differentiated instruction will cater to every student, regardless of their social and cultural background because this strategy ensures that every student participates fully and get to avail their preferred method of learning. DI has the power to benefit students' learning (Gheyssens, Struyven, & Freixenet, 2023) however, no prior studies have been conducted to determine its effectiveness in primary schools in Bhutan. Therefore, this study was designed to determine the effectiveness of using differentiated instruction in learning science for grade 5 Bhutanese students.

1.2 Research Objectives

1.2.1 To study the effectiveness of using differentiated instruction on Science learning achievement of grade 5 Bhutanese students.

1.2.2 To investigate the learning satisfaction in Science after using differentiated instruction.

1.3 Research Questions

1.3.1 Would there be any significant improvement on grade 5 Bhutanese students' learning achievement in Science after using differentiated instruction?

1.3.2 Would there be learning satisfaction after using differentiated instruction in learning Science?

1.4 Research Hypothesis

1.4.1 The use of differentiated instruction significantly improved grade 5 Bhutanese students' Science learning achievement.

1.5 Scope of The Study

1.5.1 Location of the Study

The study was carried out for grade 5 students in one of the Primary schools in Paro Dzongkhag located in the western part of Bhutan. The school has the grades from pre-primary to six.

1.5.2 Population and Sample of the study

The population of the study was grade 5 students from one of the primary schools in Paro Dzongkhag. Although there were two sections of grade 5, however

the researcher considered taking one section of 30 students using a cluster random sampling method. The research participants were of mixed gender and mixed academic learning abilities within the age range of 10 to 13 years.

1.5.3 Content of the Curriculum

This study was conducted for Science subject of grade five developed by Department of Curriculum and Professional Development (DCPD). During the research experiment, strand 1: Life Process (Topics: Nutrition and Healthy Habits) from Instructional Guide (IG), 2022 for grade 5 students was studied. The researcher conducted two classes in a week for a period of one month, which comprised of eight lessons. Four lesson plans were designed to determine the effectiveness of using differentiated instruction in learning science to the sample group students.

Table 1.1 Content of the Curriculum

Lesson plans	Topics	Teacher-Student Activities	Differentiation methods
1	Nutrition (Food Groups & Food Nutrients)	▪ Teacher will give general lesson input to the whole class. ▪ Pre-assessment of students by consultation with class/subject teacher will be done in the previous day. ▪ Division of students into three groups based on the pre-assessed information (Average, below average, and above average). ▪ Provide activities as per their readiness level. ▪ Present their activity or findings to the whole class.	Differentiated instruction based on students' readiness.

Table 1.1 Content of the Curriculum (Cont.)

Lesson plans	Topics	Teacher-Student Activities	Differentiation methods
2	Nutrition (Balanced Diet & Food Guide Pyramid)	▪ General lesson input by teacher. ▪ Provide lesson activities. ▪ Students have the liberty to choose any questions, working modality and way to express their learning. ▪ Present their activity or findings to the whole class.	Differentiated instruction based on students' interest.
3	Healthy habits (Healthy habit & Low nutritional value food)	▪ General lesson input by teacher. ▪ Provide lesson activities. ▪ Same activity questions to whole class. ▪ Students work flexibly in single, pair, or a group as per their choice. ▪ Present their work to the whole class.	Differentiated instruction based on flexible grouping.
4	Healthy Habits (Junk food & BMI Calculation)	▪ General lesson input by teacher. ▪ Divide students into three groups. ▪ Auditory, Kinesthetic, and Visual learner group. ▪ Provide activities as per the learning style. ▪ Show case their learning as per their learning style.	Differentiated instruction based on learning style: auditory, kinesthetic, & visual.

1.5.4 Time Frame

The study was carried out from May to June during the first term of the academic year, 2024. The researcher planned and conducted classes using differentiated instruction for a month. Table 1.2 below shows the time frame of the study.

Table 1.2 Time Frame for the Research Process

Activities	From		To	
	Month	Year	Month	Year
Literature Review	January	2024	February	2024
Research Proposal	March	2024	April	2024
Data Collection	May	2024	June	2024
Data Analysis	July	2024	August	2024
Final Defense	August			2024

1.6 Conceptual Framework of The Study

The study comprised of two variables; independent and dependent variable. The differentiated instruction approach was independent variable and the Science learning achievement and learning satisfaction the dependent variable.

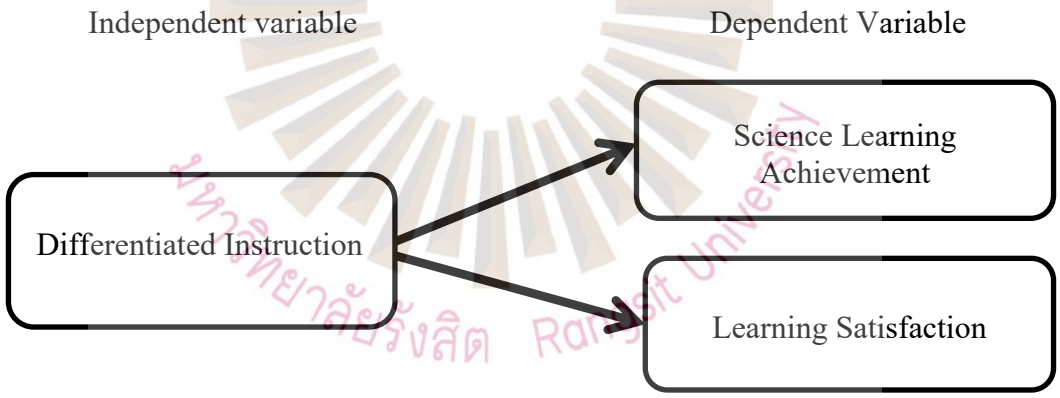


Figure 1.1 Independent and Dependent Variables

1.7 Limitations of The Study

1.7.1 The study was limited to a section of grade 5 students in one of the primary schools in Paro Dzongkhag, Bhutan. Therefore, the findings will not infer the performance of grade 5 students across the schools in Bhutan.

1.7.2 The time period for the data collection was short and restricted for a month, the content taught was limited to only two sub-topics under one chapter from grade 5 Science instructional guide. So therefore, the data collected in this study cannot be generalized to other topics and chapters.

1.8 Significance of The Study

1.8.1 The implementation of differentiated instruction had a significant impact on learning achievement in Science of grade 5 Bhutanese students.

1.8.2 The study's finding revealed positive learning satisfaction of grade 5 Bhutanese students in learning Science after using differentiated instruction.

1.8.3 The study would provide Science teachers in Bhutan with an alternative teaching strategy to enhance science learning achievement.

1.9 Operational Definitions

Differentiated instruction refers to differentiation which includes pro-active and deliberate adaptation of the science instruction by teacher based on the grade 5 Bhutanese students' readiness, learning interest, flexible grouping and learning style to facilitate students' science learning. The definition of students' readiness, students' interest, flexible grouping, and learning style are as listed below:

Students Readiness refers to the equilibrium between the information and skills that the grade 5 students need to comprehend a subject and the knowledge and skills they currently have. Nutrition lesson was differentiated based on student's readiness. Grade 5 students were arranged into three groups so they receive lessons that are an appropriate challenge to their current knowledge level. The three groups were above average, average, and the below average. The lesson was tiered by adjusting the depth of content, learning activity process and/or type of product developed by students according to their readiness, interest and learning style.

Students interest refers to grade 5 students' interest in choosing working modality and the questions. There was a set of varying level of questions developed in line to the lesson objectives. Students could choose activity questions and the work modality as per their interest.

Flexible Grouping refers to allowing the movement of grade 5 students between groups and choosing their modality of learning. Students can choose to work in group, pair or an individually for the question provided. The questions were same for all students. Healthy habits lesson consisting of first three lesson objectives were differentiated based on flexible grouping.

Students learning style refers to grade 5 students preferred mode of learning. Healthy habits lesson consisting of another three lesson objectives were differentiated based on students learning style. Students can choose how they want to learn the lesson based on their learning styles. Auditory, kinesthetic and visual were implemented as three learning styles.

Students Learning Achievement refers to Science learning achievement of the grade 5 Bhutanese students as a result of using differentiated instruction in learning Nutrition and healthy habits. The learning achievement of the students were determined through learning achievement test (Pre-test and Post-test).

Students' Learning Satisfaction refers to the positive attitude of students towards using differentiated instruction in learning and teaching Science (Nutrition and Healthy Habits). The students' learning satisfaction was measured through the semi-structured interview after the implementation of differentiated instruction in learning science.

Science refers to a subject learned by grade 5 students in this study. General science subject from grade 4 to 6 are mandatory component in Bhutanese education system.

Students refers to the grade 5 Bhutanese students studying at the research school in the academic year 2024. The students age group ranged from 10 to 13 years.

CHAPTER 2

LITERATURE REVIEW

This chapter presents the concept and the need of science education, science curriculum in Bhutan, differentiated instruction approach, concepts and definition, elements of differentiated instruction, principles of differentiated instruction, significance of differentiated instruction as a pedagogical approach in meeting diverse needs of the students and challenges in implementing differentiated instruction approach. Next, it presents the learning theories which supports differentiated instruction approach and discussion of other related research followed by the summary of literature review.

2.1 Concept and The Need of Science Education

The potential impact of science on the future of society is expected to surpass its historical influence on human affairs significantly. Scientific knowledge, considered the shared heritage of humanity, stands as a unique resource capable of addressing and alleviating inequality. It holds the promise of fostering an acceptable quality of life and a sense of purpose for a majority of the global population (Kaptan & Timurlenk, 2012).

Science education deals with sharing of science content and process with individuals who are not considered traditionally to be member of the scientific community; the individuals could be students, farmers, market women or a whole community. Science education concentrates on the teaching of science concepts, method of teaching and addressing misconceptions held by learners regarding science concepts (Aina, 2013).

School students are naturally curious, which makes science an ideal subject for them to learn. Science allows students to explore their world and discover new things. It is also an active subject, containing activities such as hands-on labs and experiments. This makes science well-suited to active younger children. Science is an important part of the foundation for education for all children. The processes and ideas of science are of great importance to everybody in three ways. The first is in their personal lives, for example so that they can validly identify the components of a healthy life-style. The second is in their civic lives, so that they take an informed part in social decisions, for example on future options for electricity supply. The third is in their economic lives, where they need to be able to respond positively to changes in the science-related aspects of their employment (Das, Amrita, & Singh, 2014). Thus, a society's schooling programme that leaves its students unaware of the strengths and limitations of science and technology would indeed be reprehensible (Fensham, 2008).

Similarly, Osborne (2007) posits that the vision of science education is to provide an education which can enhance scientific literacy. Individuals require more than a knowledge of the basic concepts of science but also a vision of how such knowledge relates to other events, why it is important, and how this particular view of the world came to be. Therefore, any science education, which focuses predominantly on the intellectual products of scientific labour- the 'facts' of science- simply fails to offer what is required.

2.2 Science Curriculum in Bhutan

Bhutan, a small landlocked country nestled in the Himalayas, has recognized the need to align its education system with the demands of the 21st century (Tenzin,2023). The Bhutanese education journey has scaled many milestones through periodic efforts in the form of policy changes and adaptations to modernistic approaches including expansion of access to education and subsequently the nationalization of school curriculum since the early 1970s, introduction of New Approach to Primary Education (NAPE) in the mid-eighties, nationalization of the

high-stake examination to Educating for GNH have been initiated strategically to improve the education system (MoE, 2014).

The transient nature of the needs of societies and learners had been the impetus and the cornerstone for the evolution of school curricula through the time. The dynamism of the curriculum is imperative to meeting the educational intentions for the nation, learners, and the societies. It leverages on the world's perpetuating diverse school of thoughts on education, culminating to radical time flamboyant curriculum, desire to redefine the meaning of curriculum, and redesign its praxis that are inclusive and comprehensive in ushering learners through their journey of learning. This presents an altogether new set of challenges and imperatives towards making educational endeavors meaningful and relevant for all through the changing time (Tenzin, 2023).

Science education has been accorded great importance ever since modern education was instituted in Bhutan (Tenzin & Maxwell, 2012). Science is a human endeavor. It is an organized and systematic body of knowledge in any field of inquiry built through the lens of the scientific process. Science basically consists of scientific content (ontology) and scientific process (epistemology). The scientific content ascribes the quantum of scientific knowledge explaining the natural and physical world, while the scientific process assists in understanding the nature of scientific knowledge; and how the scientific knowledge is constructed and accepted by the scientific community (REC, 2022).

In the early years of the Science curriculum in Bhutan, the emphasis was on teacher- centeredness at all levels. The learning process was structured without any flexibility since the syllabus "must be covered". Science learning was heavily content-based and examination-centered, that is, recitation or regurgitation of scientific facts and principles on demand (Tenzin & Maxwell, 2012). Similarly, science curriculum was heavily criticized for being fragmented and lacking a sense of progression across different grades. However, the curriculum has evolved and the science curriculum framework now emphasizes the importance of a developmentally appropriate

curriculum based on the knowledge and skills about how children develop and learn (REC, 2022).

REC (2022) stated that Bhutanese science curriculum was reformed from the point of science, technology, engineering, and mathematics (STEM) educational approach. Accordingly, REC (2022) also states that the goal of the science curriculum is to augment the spirit of STEM education in Bhutan. The hallmark of STEM education in the Bhutanese context is to foster scientifically elite professionals and technicians to contribute to national developmental activities and scientifically literate citizens who can reap every opportunity that any development in the field of science can offer in raising their living standards and life style.

Science is taught as a separate subject starting from Classes IV to VI (Key Stage 2). The Children in this key stage develop a new quality of mind (REC, 2022). The science curriculum for Classes IV to VI was developed around a series of themes that are relevant to school life. Knowledge, skills and understanding are developed in a number of appropriate contexts, with a set of values and attitudes underlying all the learning and teaching taking place (Tenzin & Maxwell, 2012). However, with globalization, the perennial goals of educating Bhutanese youths with just scientific knowledge and scientific process, has shift from the culture of silo-based science to the foundations of STEM. Therefore, the eventual aspirations of Bhutanese science education today stands more from the tone of a STEM-based approach (REC, 2022).

The Bhutanese science curriculum is one of the channels for achieving national aspirations of science education. It strives to provide bastions in nurturing the spirit of both scientific practices and engineering design. To realize such captivating curricular goals, the Bhutanese science curriculum desires to provide learning experiences in epitomizing the development of the following characteristics (REC, 2022).

1) Understand the characteristics of science, nature of science (NOS), and nature of scientific knowledge (NOSK).

2) Acquire core or fundamental scientific knowledge and understanding of the natural sciences at a level appropriate to their developmental stage.

3) Develop and apply the skills of sdcientific inquiry in understanding how scientists work; and how scientific knowledge is constructed, and accepted by the scientific community.

4) Develop and apply the skills of problem-solving through design-based learning, engineering design process, or engineering challenge.

5) Use, develop, and apply the skills of information, communication, and technology (ICT) in augmenting science and engineering practices.

6) Make learners 'scientifically literate' and be able to participate in critical and informed debates on the key questions and issues that may affect their own lives, community, country, and the world at large.

7) Prepare learners for higher studies in STEM disciplines, and also allow them to make a smooth transition into jobs that require an understanding of STEM.

8) Develop a sense of health and well-being and how to live a healthy life.

9) Inculcate in learners a love of learning science and learning STEM in general, which they carry on throughout their lives.

Learning standards are concise, written descriptions of what students are expected to know and be able to do at a specific stage of their education. The competency-based standard describes the ability to apply knowledge and skills in diverse situations that serves as the benchmark for different key stages. The students in key stage 2 (classes IV- VI) must demonstrate a number of learning standards in order to meet the aforementioned goals and characteristics. In this study, the researcher has chosen grade 5 from the key stage 2 and strand 1: Life Process as a content to teach and to be experimented. The following are the competency-based standards set for grade 5 students for the strand 1 (REC, 2022).

1) Explore variation in organisms based on their physical characteristics to understand their interaction and the importance of diversity in an ecosystem.

2) Explore the feeding relationships among organisms and the impacts of human activities on the environment to understand the importance of interdependence and protecting the environment.

3) Examine various life processes (nutrition, circulation, movement and reproduction) of animals to know their process and roles in the proper functioning of an organism.

4) Explain the process of transportation of water, minerals and reproduction in plants to understand their significance in the survival and continuity of plant life.

2.3 Differentaited Instruction Approach

> "So many students are physically present and psychologically absent. About 40 percent of students go through the motions, neither trying hard nor paying attention. So many cuts class and are truant, so many admit to cheating to get through, so many lose interest because they cannot keep up, and so many are bored by the lack of appropriate challenge. So many do not learn that ability is not enough and effort is crucial. About half of students who drop out say their classes were not interesting, and about two-thirds say not one teacher cared about their success in learning at school. Not all is rosy with teachers, teaching, and school." (Tomlinson, 2014).

The roots of differentiated instruction go all the way back to the days of the one-room schoolhouse, where one teacher had students of all ages in one classroom. As the educational system transitioned to grading schools, it was assumed that children of the same age learned similarly. However, in 1912, achievement tests were introduced, and the scores revealed the gaps in student's abilities within grade levels. In 1975, Congress passed the Individuals with Disabilities Education Act (IDEA), ensuring that children with disabilities had equal access to public education. To reach this student population, many educators used differentiated instruction strategies. Then came the passage of No Child Left Behind in 2000, which further encouraged differentiated and skill-based instruction and that is because it works (Weselby, 2014).

Contemporary student populations are becoming increasingly academically diverse and differentiation is a hot-topic in education nowadays (Jacobs et al., 2019; Subban, 2006). Student diversity within classrooms is rising both consistently and globally and provides challenges with far-reaching implications. Policy-makers and researchers urge educators to implement appropriate teaching strategies to bridge student differences and ensure that all students are given maximum opportunity to learn. Differentiated instruction (DI), which has emerged as an effective classroom practice for responding to individual differences and meeting students' diverse learning needs has become a fundamental expectation for teachers in today's classrooms (Tomlinson, 2014; Unesco, 2017).

More than ever before the world today is highly diverse, and worldwide classrooms mirror this reality. Student diversity (respectively heterogeneity) has only intensified by the recent global issues such as the COVID-19-pandemic, the migration crisis (e.g., Syrian refugees) and other armed conflicts (e.g., Ukraine and Russian conflict). Nonetheless, given that the world has become even more globalized, it has come to mean that unpredictable situations are bound to happen and thus, one can only expect that student diversity will be continuously increasing in future. With this substantial ongoing (and expected) increase of individual learning demands, the need for teachers to meaningfully address student heterogeneity in their daily teaching practice has only become more crucial (Alt & Pozas, 2023).

The school as a microcosm of the society in which it is situated is as diverse as the society. Heterogeneous classrooms pose a challenge to teachers. Teachers have to work hard to overcome the challenge posed by learners with diverse learning needs. Students come to the classroom with a variety of experiences and range of knowledge. For a kindergarten teacher, some students may be able to recite the whole alphabet because their parents worked with them on it over the summer, while other students may not have any letter recognition Overcoming this challenge calls for teachers to be creative, dexterous, and innovative in applying differentiated instruction (Amoakwah & Donkoh, 2023; Hileman, 2009).

Diversity is common, specifically in classrooms, characterized by learners' uniqueness as they project a wide array of differences. Moreover, they learn and process information in various ways. Some students prefer specific learning methods (Talian & Mercado, 2023). Differentiation is a philosophy of teaching rooted in deep respect for students, acknowledgment of their differences, and the drive to help all students thrive. Such ideas imply that teachers proactively modify curricula, teaching methods, resources, learning activities, or requirements for student products to better meet students' learning needs. The idea that learners have different learning needs and that a one-size-fits-all approach does not suffice, is gaining momentum (Jacobs et al., 2019).

Meeting the diverse and various needs of learners, who come from different cultural and social environments, imposes changes in a modern education system through the implementation of new teaching approaches and practices, such as differentiated instruction (Darra & Kanellopoulou, 2019). Differentiated Instruction has been promoted as a model to create more inclusive classrooms by addressing individual learning needs and maximizing learning opportunities. Whilst differentiated instruction was originally interpreted as a set of teaching practices, theories now consider differentiated instruction rather a pedagogical model with philosophical and practical components than the simple act of differentiating (Gheyssens, Griful-Freixenet, & Struyven, 2023).

2.3.1 Concepts and Definitions

The table below shows the concept and definitions of differentiated instruction by different researchers and authors at different times.

Table 2.1 Definitions and Concept of DI by different researchers and authors

Researcher / Author & Year	Differentiated Instruction Concept / Definition
Tomlinson (2000)	Differentiation consists of the efforts of teachers to respond to variance among learners in the classroom. Whenever a teacher reaches out to an individual or small group to vary his or her teaching in order to create the best learning experience possible, that teacher is differentiating instruction.

Table 2.1 Definitions and Concept of DI by different researchers and authors (Cont.)

Researcher / Author & Year	Differentiated Instruction Concept / Definition
Tomlinson (2001, 2014)	Differentiated instruction is proactive, where the teacher assumes that different learners have differing needs. Teachers work daily to find ways to reach out to individual learners at their varied points of readiness, interest, and preferred approaches to learning. There is no single "right way" to create an effectively differentiated classroom; teachers craft responsive learning places in ways that match their own personality and approach to teaching. Therefore, the teacher proactively plans a variety of ways to "get at" and express learning.
Alhameedyeen (2024)	Differentiated instruction is a teaching philosophy in which faculty members recognize that no two students are identical and that each student can succeed with appropriate guidance. Differentiated instruction includes differentiation of content (What is taught and how students access it), differentiation of processes (how the learning process occurs), and differentiation of outputs (how assessment is conducted.
Jacobs et al. (2019)	Differentiated instruction is a pedagogical-didactical approach that provides teachers with a starting point for meeting students' diverse learning needs. Differentiated teaching in the classroom consisting of planned adaptations in process, learning time, content, product or learning environment for groups of students or individual students. Adaptations can be based on achievement/readiness or another relevant student characteristic (such as prior knowledge, learning preferences, and interest) with the goal of meeting students' learning needs.
Koeze (2007)	Differentiation should not be examined as an instructional strategy by itself; it is a climate of learning created in a classroom by using best practices in teaching, learning, and lesson design that support student achievement.
Hileman (2009)	Differentiated instruction is defined as those practices employed by teachers who wish to recognize that each student is at a different academic level and that these differences affect how students learn. Educators then make adjustments to their instruction. In the profession, this is known as differentiated instruction.

Table 2.1 Definitions and Concept of DI by different researchers and authors (Cont.)

Researcher / Author & Year	Differentiated Instruction Concept / Definition
Meriyati et al. (2023)	Differentiated Instruction strategy is a method used to adapt the various characteristics of students to learning and assessment, which does not only use one strategy but combines several suitable strategies.
Am, Hadi, and Istiyono (2023)	Differentiated instruction is an important teaching approach that adapts educational experiences to fit the varied needs and learning styles of students in the classroom.

2.3.2 Elements of Differentiated Instruction

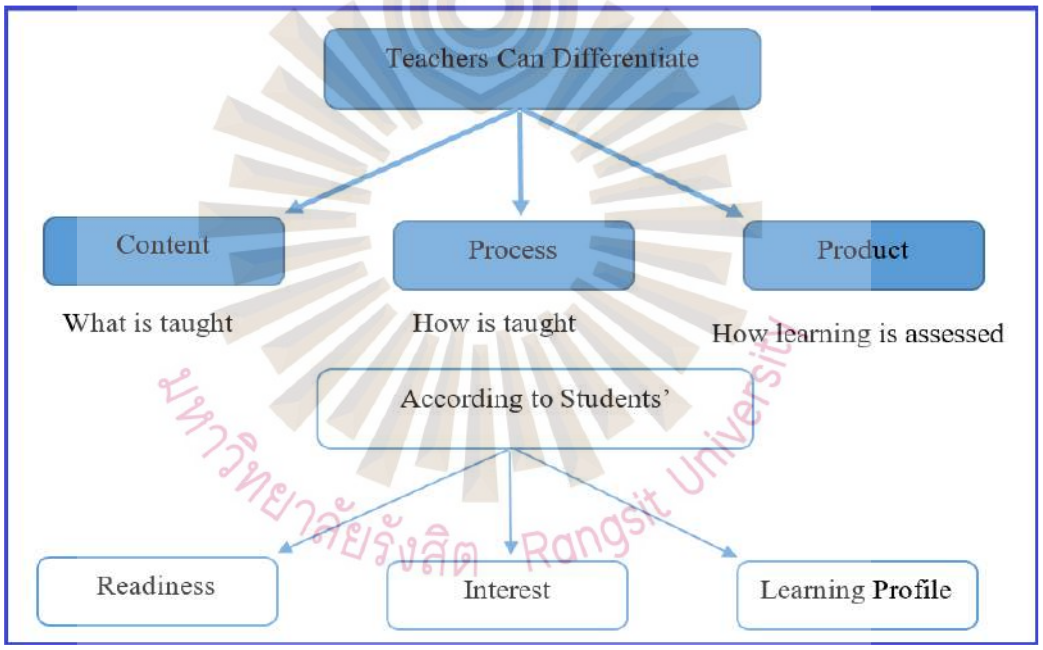


Figure 2.1 Tomlinson's model of differentiated instruction

Source: Alsalhi et al., 2021

Tomlinson (2000) identified four significant elements of differentiated instruction. The elements are intricately linked and can be tailored to the student's readiness, interest, and learning profile:

1) Content: The content refers to topics, concepts or themes. The differentiating content includes what the student needs to learn or how the student will

get access to the information. It involves providing students with various resources and choices that match their readiness, interests and learning profiles to select and access the materials taught (Tomlinson, 2000, 2014).

Several ways are proposed for differentiating content. Teachers may use flexible grouping where students can work in small groups or alone to reinforce content; highlight or summarize key portions of content with illustrations or colors; present material in visual, auditory or kinesthetic ways; provide lecture videotapes; use books, pictures or Internet as a means of developing understanding and knowledge of the topic or concept; use examples that relate to students' experiences or knowledge to practice situations or explain contents (Tomlinson, 2001).

2) Process: The term process refers to the activities in which the student engages in order to make sense of or master the content; in other words, it is how the students must complete the learning content (Tomlinson, 2000, 2014). The differentiating process involves applying varying activities and techniques which can provide more opportunities for students to learn best and display individual strengths (Tomlinson, 2001). It concerns not only how teachers teach but also involves strategies that teachers encourage students to use to facilitate exploring the content taught. This can be done by tiering the course content and activities that can make students learn step by step; providing guidelines for every step of learning; using differentiated tactics to increase student interaction, engagement, higher order thinking and critical thinking during class time (Tomlinson, 2000, 2001).

3) Product: It is a project that students complete at the end of a unit to demonstrate what they have learned. The traits of successfully differentiated products contain providing evident and proper guides for success, focusing on real-world application, advancing creative and critical thinking, requiring analysis or synthesis of information, permitting diverse methods of expression and providing opportunities for peer and self-evaluation (Tomlinson, 2001). To differentiate product, teachers can encourage students to express what they have learned in varied ways, offer opportunities for student-derived topics for projects; allow for varied working arrangements—alone or with a group; provide clear guidelines for independent work that matches individual needs; and use a wide variety of assessments or assignments for students (Tomlinson, 2001).

4) Learning Environment: The Learning Environment refers to the way the classroom works and feels. Instructors who differentiate, value and care for their students, which is evident in the excellent classroom environment favorable to success. The physical aspect of the classroom is the first step in creating such an environment. When the classroom is friendly, students are more responsive to learning and have a sense of community. Teachers, for example, pay attention to the arrangement of the furniture, their level of comfort, providing materials that reflect a variety of cultures and home settings, helping students understand that some learners need to move around to learn, while others do better sitting quietly, the sound volume, the temperature, and the lighting in the class (Tajik, Noor, & Golzar, 2023; Tomlinson, 2000).

A lesson can be differentiated in many ways to best meet the needs of all learners. According to Koeze (2007), the most prevalent ways that differentiation occurs is by readiness, interest and learning profile of the students.

If lesson is based on students' readiness, lesson would be designed to challenge students at all levels of the achievement spectrum-the high, low, and middle. It is important to note that students' readiness levels are fluid as they may have different levels of readiness for varying content areas and topics within the content. Tomlinson (2000) defined readiness as the students' entry point relative to a particular understanding or skill.

A lesson organized around interest gives students a choice in how they learn the lesson. Students may be placed into groups based on a variety of ways including learning styles, interest, choice, or they may work independently to complete the assignment. For example, if the concepts of photosynthesis were being taught, some students may be interested in writing a report or drawing a diagram explaining the concepts. Other students may be interested in designing an experiment to see what types of conditions are best for photosynthesis to occur. Students would have choice as to how to demonstrate their knowledge of the concept. The teacher can control the choice by creating a choice chart where students select their preferred way to demonstrate understanding of the topic.

A lesson designed to meet the learning profile of students would take into consideration the way in which the students best process information and ideas, and ways in which learning style, gender, culture, and intelligence preference influence the students. Teachers need to recognize and understand if a student isa whole-to-part, part-to-whole learner; likes to work in silence, groups, independently; through written expression, speaking, and so on. It is important that students also understand their learning strengths so they can make the appropriate choices within the classroom. The teacher would accommodate for differences in how students learn so optimal learning can take place.

2.3.3 Principles of Differentiated Instruction

The main principles of DI according to Alsalhi et al. (2021) are shown below:

1) Teacher will not be in a situation utilizing one method of teaching that suits all needs of every student.

2) All students are involved in substantial and meaningful work or tasks.

3) Teachers and students are working closely to guarantee ongoing engagement and challenge for each student.

4) The teacher schedules time, place, and activities to utilize for his students in the classroom.

5) It provides a learning environment appropriate to all students, students have various prior backgrounds, and thus teacher should distinguish and recognize to suit all these backgrounds.

6) Differences between the students offer teachers the ability to differentiate instruction.

7) Students know more when they get appropriate support.

8) Flexible grouping contains instructions for whole-class, pairs, selective groups of students, and random groups.

9) If students link their personal interest and attitude with the curriculum, this will lead them to a better achievement.

10) Teacher understands the differences between the students.

11) All learners engage in productive work.

2.3.4 Significance of Differentiated Instruction as A Pedagogical Approach in Meeting Diverse Needs of The Students

> "In most elementary classrooms, some students struggle with learning, others perform well beyond grade-level expectations, and the rest fit somewhere in between. Within each of these categories of students, individuals also learn in a variety of ways and have different interests. To meet the needs of a diverse student population, many teachers differentiate instruction." (Tomlinson, 2000).

In heterogeneous classrooms, teachers design instruction that accommodates and addresses the diverse learning needs of each student. Amoakwah and Donkoh (2023) also stated that: Teaching students in a classroom as though they have the same abilities and socio- economic background puts some students at a disadvantage. One way of ensuring that all students in a diverse classroom successfully learn is by applying differentiated instruction. In line to that, owing to the difference or sameness of students in the classroom, Chalermnirundorn (2019) concluded that, schools, teachers, educators have more responsibilities in providing fair opportunities for all kind of learners. In other words, individualization or personalization (design for learning) should be recommended to satisfy the uniqueness of individual learners for effective academic outcomes and achievement in education in all levels.

Bi, Struyven, and Zhu (2023) stated that, as the diversity of student increases, DI serves an increasingly significant function in meeting their individual learning needs. Classrooms are currently filled with students who have enormous differences in their readiness, interests, cultural backgrounds, prior knowledge, and learning profiles. Looking at a typical classroom and the ability levels within it, one can conclude that teachers who do not differentiate teach only a fraction of their students. In a DI environment, each student is valued for his or her unique strengths, while being offered opportunities to demonstrate skills through a variety of assessment techniques

(Subban, 2006). Thereby in order to cater to every individual, in DI, the teacher plans and carries out varied approaches to content, process, and product in anticipation of and response to student differences in readiness, interest and learning needs (Koeze, 2007).

Differentiation focuses on optimizing learning and learning conditions (including the learning environment) for all students; thus, it is an inclusive pedagogical approach (Loreman, 2017) where all students feel respected, safe and supported to participate and learn for maximum student achievement. Scarparolo and Subban (2023) also explained by saying that, once teachers have chosen to adopt the philosophy and mindset of differentiation and they know their students, the next step of differentiated instruction is matching instruction to the elements of student diversity with the aim of increasing student motivation, engagement and maximizing achievement. When teachers use effective instructional approaches as part of their practice, they maximise the probability that students will be actively engaged in instruction. Student engagement is one of the most well-established predictors of achievement.

Tomlinson (2014), stated that, teachers in differentiated classrooms begin with a clear and solid sense of what constitutes powerful curriculum and engaging instruction. Then they ask what it will take to modify that curriculum and instruction so that each learner comes away with knowledge, understanding, and skills necessary to take on the next important phase of learning. Essentially, teachers in differentiated classrooms accept, embrace, and plan for the fact that learners bring to school both many commonalities and the essential differences that makes them individual. Teacher's goal in differentiated instruction classroom is student learning and satisfaction in learning, not curriculum coverage.

Differentiated instruction has many benefits for both the students and the educator (Darra & Kanellopoulou, 2019) since differentiating the educational process necessitates changing the teaching technique to make it more relevant for the target learners. With differentiated instruction, students are at the center of the teaching

process, their needs and preferred ways of learning are met and their success is assured (Tulbure, 2011). In addition, differentiated instruction enables educators to respond rather than react to students' unique and individual personalities, backgrounds, and abilities. Tomlinson (2014), emphasized that in differentiated classroom, teachers have to work daily to find ways to reach out to individual learners at their varied points of readiness, interest, and preferred approaches to learning. There is no single “right way” to create an effectively differentiated classroom; teachers craft responsive learning places in ways that match their own personality and approach to teaching. As DI classroom use those inclusive instructional practice, therefore, it can respond to the continuously increasing student diversity (Alt & Pozas, 2023).

Differentiated classroom differs from a traditional classroom in many ways since differentiation allows teachers to vary the ways in which students work, alone or in groups, auditory or visual means, or creatively to further enhance student learning (Koeze, 2007). Furthermore, Hileman (2009), also reported the five elements of differentiated classroom: such as, teacher being clear of learning goals, grouping students flexibly, using time, space and materials flexibly, teacher understanding the nature of classroom and making it work for everyone, and emphasizing individual growth as central to the success of the classroom. In that way all students get equal treatment while availing the education facility (REC, 2019) since educators cannot afford to continue believing that all students learn in the same way, using the same content and material, and be taught and assessed in the same way. It is time schools and the education sector recognize, nurture and celebrate the differences. Therefore, differentiating instruction allows students to be academically engaged in their work because they are presented material that engages their thinking process. The framework for the use of DI is given below.

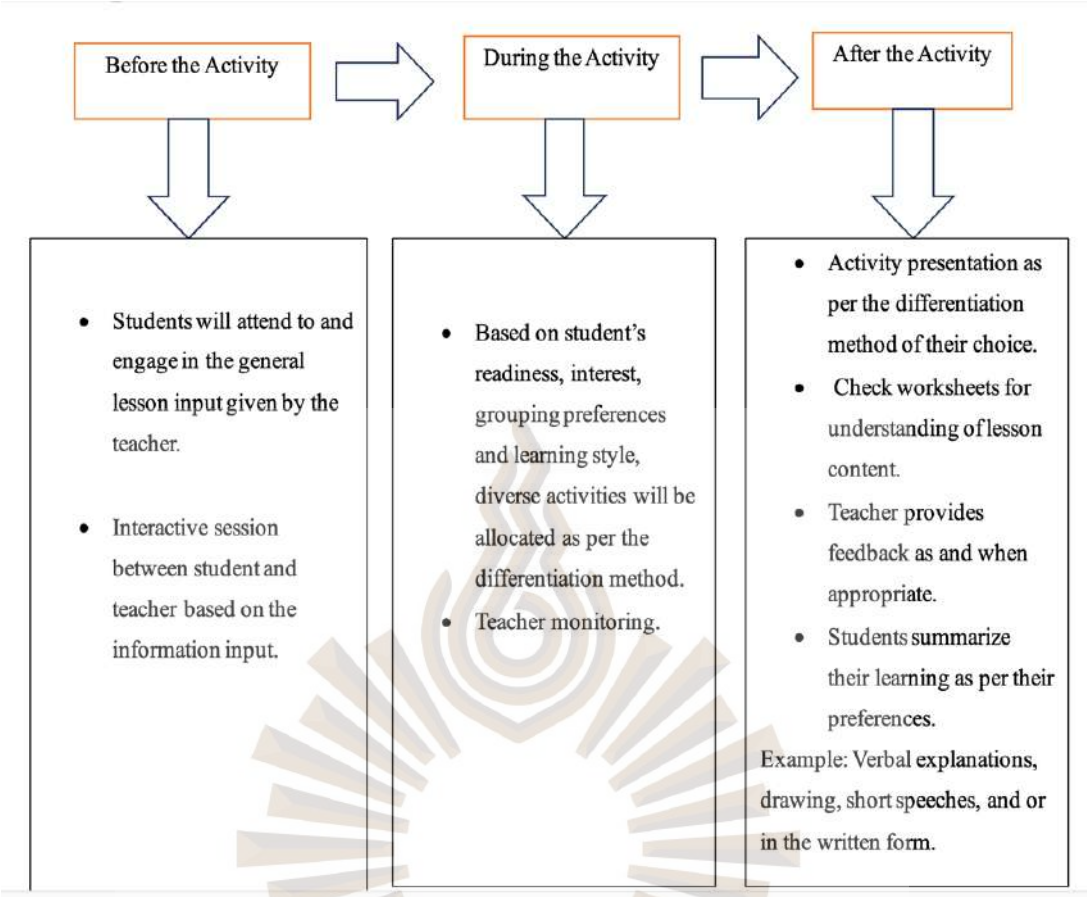


Figure 2.2 A Framework for the use of Differentiated Instruction in a Science class
Source: REC, 2019

2.3.5 Challenges in Implementing Differentiated Instruction Approach

Research has shown that differentiated instruction has a positive impact on student learning, leading to increased student engagement, improved academic achievement, and greater student satisfaction (Lin, Wu, & Yang, 2021). However, despite its potential benefits, implementing differentiated instruction in the classroom can be challenging and requires a lot of planning and preparation. UNESCO (2017), also is of the opinion that, including all learners and ensuring that each individual has an equal and personalized opportunity for educational progress is still a challenge in almost every country. Therefore, it is important to understand the concept of DI and the research that supports it in order to effectively implement it in the classroom (Am et al., 2023).

Although, as Munro (2012) points out, DI is recognized as an approach that meet the individual needs of all students, especially those with learning difficulties, and is increasingly considered as the responsibility of classroom teachers, differentiated instruction does not seem to be widely and frequently used (Kiley, 2011). Similarly, according to Papanthymou and Maria (2022), many teachers hesitate to implement DI strategies in the classroom because they believe they lack time, administrative support, and necessary resources for professional development, while some teachers see DI as another bureaucratic mandate heaped onto their already burgeoning workloads.

Additionally, Yuen, Westwood, and Wong (2005) reported the difficulty in implementing DI strategies, and especially sustaining its use over time. Key barriers to differentiation include limited preparation time, large classes, workload, lack of resources, teachers' lack of differentiation skills, and teachers' lack of motivation to differentiate. In general, DI is considered an important but complex teaching skill that many teachers have not mastered and feel unprepared to implement (Geel et al., 2019). Therefore, it can be a daunting task for teachers as it requires a new way of thinking about curriculum and teaching (Tobin & Tippett, 2013).

The challenges of effectively teaching students with learning difficulties can be mitigated by providing teachers with the training and resources they need to implement DI strategies. These resources include access to robust professional development and adequate staffing ratios to manage the demands in inclusive classrooms. If DI is implemented as intended, it can be a powerful tool for the success of all students. However, without proper support and resources teachers may lose faith in these strategies and write them off as another educational fad that will eventually die out (Gibson, 2013).

2.4 Learning Theories Related to Differentiated Instruction Approach

Educational philosophies and learning theories underpin all educational practices, because they provide the conceptual frameworks describing an individual's acquisition of knowledge, skills, and attitudes to achieve changes in behaviour, performance, or potential (Mukhalalati & Taylor, 2019). Similarly, Rad (2012) defined learning theories as a conceptual framework that describes how information is absorbed, processed, and retained during learning. Learning theories are the main guide for educational systems planning in the classroom. The teachers by knowing the general principles of these theories can use their knowledge more effectively according to various learning situations (Aliakbari, Parvin, Heidari, & Haghani, 2015). The researcher has identified the following theories of learning that are in favour of differentiated instruction.

2.4.1 Multiple Intelligence Theory

Howard Gardner proposed the 9-dimensional model of intelligence to define a broad spectrum of intelligence quotient (I.Q). According to Gardner, intelligence is not a static concept or quality but has a range of dimensions that are expressed in the people in varying quantities that facilitate and flourish the specific aspect of intelligence. Intelligence can be linguistic, mathematical, spatial, kinesthetics, naturalistic, musical, interpersonal, intrapersonal and existential. The theory implies that these aspects of intelligence are exclusive and can work independently but usually they operate together (Gardner, 2011).

For example, the teacher should try to design the modes of instruction that not only use linguistic intelligence by just delivering the lecture that would only focus the students with linguistic intelligence but also include graphical models, figures, and videos to stimulate different areas of intelligence through their lecture. For instance, a good debater with excellent linguistic intelligence can be more impressive by applying emotions and expressions to their speech by using intrapersonal intelligence (Waseem & Aslam, 2021).

According to Zen (2021), DI is supported by multiple intelligence (MI) theory because the theory does allow an option for differentiation based on how students prefer to learn. DI facilitates the construction of knowledge based on individualized learning styles with the teacher as a facilitator mediating between the different learning styles of students.

Gangi (2011) found out that Gardner's MI theory is one method to effectively differentiate instruction in the elementary school classroom. It allows teachers to approach a lesson in a variety of ways while attending to the learning needs of each student. The use of MI in the classroom allows teachers to provide students with rich experiences-activities in which they can engage with the material personally rather than just absorb it in an abstract way. Rich experiences often incorporate many intelligences into one lesson or unit. For example, a class may be working on the water cycle. Students can act out the water cycle, draw a mural, write a story, or sequence the order of the cycle, among other activities that incorporate the intelligences.

Amoakwah and Donkoh (2023), states that DI principally hinge on Howard Gardner's MI theory. Since every individual possesses the full range of intelligence, and no two individuals exhibit the same profile of intellectual strengths and weaknesses, the teachers should plan and strategize their classroom lessons to suit the diverse needs and abilities of learners in the classroom as DI seeks to maximize the skill set of learners. With DI, students rely on their strongest intelligence when dealing with their tasks. So, when teachers provide students with tasks and they allow the students to apply their preferred intelligence in dealing with the given task, the students become successful.

Similarly, Koeze (2007) also agrees with that the ideas of DI approach match with that of the MI method because in a differentiated classroom, the teacher takes the multiple intelligences into account when designing lessons and activities that go along with the lessons. The learning needs of the students are met through the variation in content delivery, group structure and taking in the account of students learning profiles. Learner profiles such as learning styles allow the teacher to understand how a

student learns best: by doing, by listening, by working alone, in a space other than a desk, in bright light, dim light, and so on. In that way, MI theory helps the teacher to understand the innate strengths the child brings into the classroom, such as verbal/linguistic or bodily/kinaesthetic intelligences. Therefore, it is important that both the teacher and student understand the importance of multiple intelligences and learning styles. When both the teacher and student understand the learning strengths of the child, appropriate choices can be given on how best to design and complete a lesson.

2.4.2 Constructivist Theory (cognitive constructivists and socio-cultural constructivism)

Constructivism is an epistemological and a psychological theory of learning that explains knowledge and the meaning making processes. According to constructivism, individuals construct new knowledge through the interaction between their previous skills and knowledge, the skills and knowledge gained from social interaction with peers and teachers, and social activities. Knowledge is actively constructed based on a learner's environment, the physical and social world, which makes it relative. The constructivist theory approaches pedagogy and learning holistically, focusing comprehensively on the internal cognitive mechanisms that underlie the learning processes, participation, and social interaction (Mukhalalati & Taylor, 2019).

Zen (2021) stated that constructivist learning theory is one of the educational theories that supports DI. In DI classroom, students actively create, interpret, and reorganize knowledge in individual ways which compliments the concept of constructivism approach. Students create knowledge through exploration and discussion. The role of a teacher is that of a facilitator, motivating and guiding the students so that students are actively involved in the learning process. Thereby, teachers help students construct knowledge rather than reproduce a series of facts and the student is in the center of education and learning.

2.4.3 Vygotsky's Zone of Proximal Development (ZPD)

Vygotsky's zone of proximal development theory implies that the quality and depth of learning that occurs through an interaction between the learner and the 'more knowledgeable other' (MKO) would be higher than what the learner learns independently. This additional benefit in depth of knowledge achieved by learning through the facilitation by the facilitator is considered zone of proximal development (ZPD) (Shabani, 2016).

Waseem and Aslam (2021), opined that the teacher in the classroom has the responsibility to identify the areas of the curriculum which a student can cover independently and those which a student cannot. The teacher needs to invest time on the activities and design the activities in such a way that areas of curriculum which need assistance by teacher are covered through the help of the teacher. To promote a better understanding of the concepts the instructional designs need to be optimized and 'scaffolding' is the tool to be utilized. In scaffolding, the role of the teacher is not simplified but the role of learner is simplified through programmed and measured interventions by the teacher. In that case, the application of Vygotsky's theory complements the ideas of adapting the concept of content and process of DI approach.

Amoakwah and Donkoh (2023) claims that the Vygotsky's ZPD theory has a sequential influence on DI since it stresses on social interaction between teacher-students and student-teacher. Vygotsky opined that learners are the creators and constructors of their knowledge. Vygotsky underlines that social interaction and cultural interplay exert a significant role in learning. Vygotsky considered learning as a process rather than a product. Knowledge is earned as learners discuss, interact and compare ideas, and shares their thoughts with others within their environs such as teachers and the MKO.

2.4.4 Brain-based learning theory

Brain Based Learning theory is based on the structure and function of the brain. As long as the brain is not prohibited from fulfilling its normal processes,

learning will occur. People often say that everyone can learn. Yet the reality is that everyone does learn. Brain-Based Education is the purposeful engagement of strategies that apply to how our brain works in the context of education. Brain-based education emphasizes how the brain learns naturally and is based on what we currently know about the actual structure and function of the human brain at varying developmental stages (Ramakrishnan, 2018).

Arun and Singaravelu (2018) asserted that, effective teachers never stop considering different ways of method of teaching to improve student achievement. Each teacher is different from each other from their learning style. Brain research has provided new knowledge about the many ways that humans learn as brain-based learning deals with the concept of learning in a neuro-physiological context of learning. Brain is the basic factor in learning, so learning is affected by environmental factors, psychosocial qualities of the individual and chemical structure of the organism and these interactions reflect on the process of learning.

According to Koeze (2007), the practice of differentiation is firmly grounded in brain research. In a differentiated classroom, teachers who tier their lessons to match the readiness levels of their students eliminates both boredom and frustration in their learning process. Brain research confirms that the human brain functions by paying attention to meaningful information. In order to deliver meaningful information, differentiation of instruction involves developing of appropriate challenges and engaging lessons for students based on their interests, ability and learning needs. Therefore, a teacher who differentiates by student readiness is meeting the need of the human brain and adjusting to what they currently know. This, in turn, enhances student's learning. A brain compatible environment ensures that learning takes place. Thus, a differentiated classroom is organized in a manner to alleviate student stress and increase student interest in their learning by developing lessons according to the needs of students.

In discussing about the DI approach relating to brain-based learning theory, Tomlinson and Kalbfleisch (1998) are cited by Kado et al. (2021, p.30) as suggesting

that: DI in teaching and learning involves three broadly related concepts. First, the learning environment should be conducive to learning. The learners who are intimated, unsafe, feel dejected, and pressured are improbable to learn. Second, the learners need to be appropriately challenged in order to maximize the learning. The contents delivered should be neither too easy nor too difficult but appropriate to their readiness. Third, the learners must be able to make the connection between the existing and prior knowledge. When the teachers deliver the instructions, a teacher should access the prior knowledge instead of teaching facts and figures in isolation. These concepts of DI in teaching and learning complements the three brain research principles such as emotional safety, appropriate challenge, and self -constructed meaning.

2.5 Related Research and Studies

A number of researches on the use of DI approach in teaching and learning were carried out around the globe in various grades for different subjects. In almost all the studies, DI approach has been seen as a successful measure. Some of the researches by different authors have been discussed below.

Kado et al. (2021) carried out research on title "The effect of differentiated instruction on academic achievement of grade eleven students in the field of derivative in Bhutan" used pre-test and post-test quasi-experimental research method to examine the results of DI approach upon learning achievement. A Conceptual Understanding Test on the Derivative (CUTD) was administered as pre-test and post-test groups to examine the differences in their learning achievements. A t-test analysis of the pre-test indicated no significant differences, indicating that the experimental and control groups' learning abilities on the concept of the derivative were roughly comparable. However, a statistically significant difference in favor of the experimental group over the control group was discovered in the post test analysis.

Based on this finding, this study demonstrated that differentiated instructions customized to students' learning profiles, needs, and preparedness improve their derivative performance. Students who received differentiated instruction strategy

excelled to those that received a typical one-size-fits-all approach. Since differentiated teaching has consistently improved students' achievement in mathematics in general and it is derivatives in particular, it is a promising technique for meeting the demand for a variety of learners in mixed ability classes.

Moreover, this work unraveled and shed light on the understanding of the differentiated approach as a unique and novel educational pedagogy for teaching and learning the derivative concepts relationally rather than through rote memorization, which is a cornerstone of traditional teaching methods.

In the study conducted by Koeze (2007) on "Differentiated instruction: The effect on student achievement in an elementary school", the researcher examined seven fourth grade classrooms to determine if differentiated instruction has an impact on student achievement. The intent of this study was to investigate the best practices of teaching and learning and to get into the classroom to see the reality of what was really happening that promoted student learning. The study used a mixed method design. The data were triangulated through the use of teacher surveys, students' surveys, and classroom observations. This study supported the fact that differentiating learning styles increases student achievement. Through the use of quantitative and qualitative data gathering, patterns emerged in support of the differentiation variables that had a positive relationship to student achievement.

Alsalhi et al. (2021) investigated on "Impact of using the differentiated instruction (DI) strategy on student achievement in an intermediate stage science course". The study aimed at investigating the effects of the us of DI strategy on students' achievement in science course at the intermediate stage and their attitudes towards it. The study was conducted using a semi-experimental method. The total participants for the study were four hundred eighty-three students. Achievement tests and questionnaires were used as tools for the study. The results indicated that there were statistically significant differences between the groups for the benefit of the group that was taught via DI. The results also revealed positive attitudes towards the strategy used.

The study recommends that attention to applying the differentiated teaching strategy for teaching science curricula and other textbooks because it is considered as one of the most modern and advanced teaching strategies to take into account of different needs, inclinations, interests, and the differences between their levels in understanding.

Similary, Safawi, and Akay (2022) researched on the title "The effect of differentiated instruction approach on students' academic achievement and attitudes: A meta- analysis study". In order to study the effect of differentiated instruction approaches on students' academic achievement and attitudes in this meta-analysis, CoHE Thesis Center, Google Scholar, Dergi Park, Research Gate, and ERIC search engines were used to retrieve studies published in Turkey between 2010 and 2021. Out of 23 quantitative studies selected,10 experimental and 13 quasi-experimental studies focused on students' academic achievement and eight quantitative studies comprising three experimental and five quasi-experimental studies focused on students' attitudes. These studies measured the pretest-posttest differences between the experimental and control groups using parametric tests such as t-test, ANOVA, and ANCOVA.

According to the resultant findings of the meta-analytic reviews of studies on the effects of differentiated instruction approach on students, the following recommendations are presented:

1) DI has equal effects on all education levels and increases students' academic achievement and attitude at a positive and significant level. Therefore, it should be used in education levels ranging from primary school to university.

2) DI approach should be used more in education, as it is more effective than traditional instructional methods.

3) The longer the duration of the DI approach, the more positive student achievement and attitude will be effective. Thus, it should be continuously used in education.

Additionally Ponmozhi and Ezhili (2023) researched on the title, "A study on Effectiveness of Differentiated instruction on Higher Secondary School Student's

Achievement in Mathematics". It was carried out to determine the effectiveness of DI on higher secondary school student's achievement as compared to the traditional method of teaching in the subject of mathematics in Cuddalore District, Tamilnadu, India. The target population were higher secondary school students, a sample of 25 students were selected. Control group was taught through normal lecture method. Treatment group was taught through DI. Differentiation of content, process, product, affect and learning environment was created.

The study clearly depicted the achievement in treatment group. The study also suggests to teachers to take essential steps to teach their subject in various innovative teaching techniques to attain master learning for their students. So, it is essential for all the teacher to learn innovative techniques like DI in teaching to increase their effectiveness.

The study conducted by Magableh and Abdullah (2020) examined the effectiveness of differentiated instruction on primary school students' English reading comprehension achievement. In this study four classes of (n=118) students of the primary level from 4 different schools were selected. Two levels of grade 4 students (n=59) and two levels of grade 5 (n=59) were divided into two control and two experimental groups. One level of (n=30) students formed grade 5 experimental groups, and one level of (n=29) formed the control groups. Moreover, one level of (n=30) students of grade 4 formed the experimental group, and one level of (n=29) formed the control group. The teachers followed DI strategies of flexible grouping, tiered instruction, and tiered assignments in the areas of content, process, and product to teach the experimental group. However, they followed the one-size-fits-all method to teach the control group.

The findings revealed that DI approach had a positive impact on English reading comprehension achievement in levels 4 and 5 in Jordan. Besides, the results of the study showed that implementing differentiated teaching in a mixed-ability classroom reduced students' diversity to be more homogeneous. At the primary level, students do not know how to read, learn, and do not know how to complete assignments. So, implementing DI

strategies like differentiated content, tiered activities, and tiered assignments contributed to their accomplishment. So, DI can help reduce this classroom diversity by separating the content, process, and product. This study mainly revealed that implementing modified education on primary students can lead to improving their reading comprehension development as DI helped improve the primary students' reading comprehension in Jordan.

Analyzing the numerous studies conducted by many researchers, it is fair to conclude that DI learning approach is one of the effective approaches that actively engages students learning by meeting diverse learner's need. However, no research has been conducted using this strategy in primary school of Bhutan, so the researcher will use this strategy to determine whether differentiated instruction learning approach will help grade 5 Bhutanese students science learning achievement and to investigate their learning satisfaction.

2.6 Chapter Summary

Teaching has always been a demanding job, but it has become even more demanding as students come into the classroom with a wider variety of experiences, backgrounds, learning abilities, and perceptions about school and school work than ever before. No longer does one teaching method or one type of homework seem to fit the bill for the variety of students entering schools today (Dwayne, 2015). Based on modern trends in education and calling for the need to provide education to all members of society taking into account the difference between them, the teachers of today should be proactive and creative enough to design learning for various learners.

In the present scenario with the changing time, most of the science teaching strategies and the curriculum that has been used over the years are not as efficient as in the past. The traditional concept of one size fits all no longer serves the purpose of learning. The need for the differentiated curriculum and instruction is highly on demand. Similarly, extensive cognitive engagement with critical content in an instructional unit are becoming more important in learning than content coverage for

overall mastery of the content. Therefore, the idea of teaching less content, but teaching it more thoroughly is a sound teaching principle across the globe.

To ensure that every primary student receives fair, equitable and meaningful science learning from the class, one of the methods is use of DI learning approach. This is because, DI is a pedagogical-didactical approach that provides teachers with a starting point for meeting students' diverse learning needs. Most educators today should believe that students learn in a variety of ways, and that attention to these learning styles and preferences positively impacts student engagement with the academic content and ultimately student achievement.

Having gone through several research and studies on DI learning approach, it is observed that learning through DI approach has several positive impacts in students learning achievement. Since DI caters to the need of various learners by adapting content, process, product and learning environment. Therefore, student learning achievement using this approach is usually higher than those students who are taught through traditional method of one size fits all approach. Further, it engages and motivates students to take part in their learning process despite their differences. This gives students the sense of satisfaction in their learning. Thus, the researcher implemented DI learning approach as a teaching-learning approach in the Bhutanese classroom context.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter contains the described general procedures used to conduct the study. It covers research design, research method, the study's population and sample, the data collection tools used, the instruments validity and reliability, and the data analysis process. of the study, research instruments, validity and reliability of the instruments, data collection procedures and data analysis techniques. Additionally, ethical considerations and potential limitations of the study are also discussed in this chapter to ensure the validity and credibility of the research findings.

3.1 Research Design

In this study, the researcher adopted mix method design. According to Nair and Prem (2020), mix-method research (MMR) is a distinctive form of research method using both quantitative and qualitative research methods so that strong empirical evidence is obtained. It helps the researcher to gain a deeper understanding and confirmation while enabling the elimination of the weakness of each study if carried out in silos. This design offers people the choice of participating in a way that best suits their survey-taking preferences and resources (Wilkinson & McTiernan, 2020). A mixed methods study is one that includes a qualitative and quantitative dimension, where combination of these will enable a broader reach in empirical studies (Doyle, Brady, & Byrne, 2009).

Additionally, Dawadi, Shrestha, and Giri (2021), conveyed that MMR as a flexible and adaptive conceptual framework for designing and conducting mixed methods research in a simplified manner. A mixed-methods design offers a number of benefits to approaching complex research issues as it includes philosophical

assumptions to provide directions for the collection and analysis of data from multiple sources in a single study. It also offers a logical ground, methodological flexibility and an in-depth understanding of smaller cases (Maxwell, 2016). Therefore, the use of mixed-methods can enable researcher to answer research questions with sufficient depth and breadth (Enosh, Tzafrir, & Stolovy, 2014) and help generalise findings and implications of the researched issues to the whole population.

The purpose of this study was to determine the effectiveness of using differentiated instruction on learning achievement of grade 5 Bhutanese students in science and to investigate the learning satisfaction of the students towards the use of differentiated instruction in science. Hence, the researcher, after considering the applicability of mixed method design, a combination of both quantitative and qualitative method was used in this study. The figure 3.1 illustrates the research design of the study.

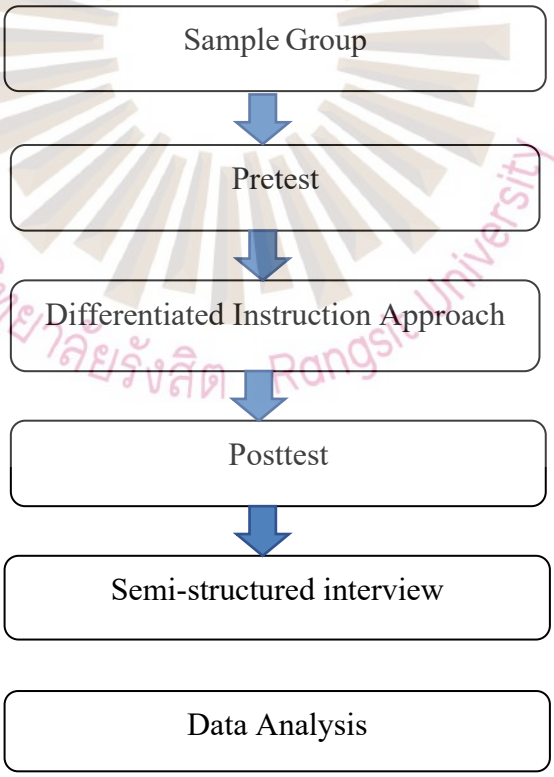


Figure 3.1 Research design of the Study

3.2 Population and Sample of The Study

This study was carried out in one of the primary schools in Paro Dzongkhag, which is located in the western part of Bhutan. Although there were two sections of grade 5, however the researcher considered taking one section of 30 students using a cluster random sampling method. The research participants were of mixed gender and mixed academic learning abilities within the age range of 10 to 13 years. Table 3.1 presents the demographic details of research participants in terms of gender and age.

Table 3.1 Demographic detail of the research participants

Details	Gender		Total
	Male	Female	
Number of students	16	14	30
Age range	10-13	10-13	

3.3 Research Instruments

According to DiscoverPhDs (2020), the term research instrument refers to any tool used to collect or obtain data, measure data and analyze data that is relevant to the subject of research. SCISPACE (2024) states that it is used to collect, examine, investigate a problem, and present data more systematically and objectively. Research instruments can be in the form of questionnaires, interview guides, or other tools used to gather data for a study. So, therefore the researcher used lesson plans, learning achievement tests (pre-tests and post-tests), and semi-structured interview to collect and assess data for this study.

Table 3.2 Implementation of instrument for each Objective

Sl.No	Research Objectives	Research Instruments
1	To study the effectiveness of using differentiated instruction on Science learning achievement of grade 5 Bhutanese students.	Learning achievement tests; pre- and post-test
2	To investigate the learning satisfaction in Science after using differentiated instruction.	Semi-structured interview questions

3.3.1 Instructional Instrument

Lesson Plans

According to Trigueros (2018), a lesson plan is defined as a source or tool that guides teachers through their working learning process. It is imperative for a teacher to plan their lessons since this has the content, method, activity, practice and material the teacher will use in the development of the class. Teachers that do not use a lesson plan usually mislead the learning process. In this study, the researcher prepared four lesson plans of 90 minutes each. One lesson plan covered two periods of 45 minutes each. The lesson plans were designed to teach the Science subject from the prescribed curriculum developed by Department of Curriculum and Professional Development (DCPD). During the research experiment, strand 1: Life Process (Topics: Nutrition and Healthy Habits) was taught. (Refer Appendix D for sample lesson plans).

The researcher conducted two classes in a week for a period of one month, which comprised of eight lessons. The lesson plans were used to determine the effectiveness of using DI in learning Science to the sample group students.

Table 3.3 Framework of the lesson plan

Lesson Plans	Topic	DI Method	Time
Lesson Plan 1	Nutrition (Food Groups & Food Nutrients)	Differentiated Instruction based on students' readiness.	Week 1
Lesson Plan 2	Nutrition (Balanced Diet & Food Guide Pyramid)	Differentiated Instruction based on students' interest.	Week 2
Lesson Plan 3	Healthy habits (Healthy habit & Low nutritional value food)	Differentiated Instruction based on flexible grouping.	Week 3
Lesson Plan 4	Healthy Habits (Junk food & BMI Calculation)	Differentiated Instruction based on learning style: auditory, kinesthetic, & visual.	Week 4

3.3.2 Quantitative Data Collection Instrument

Learning Achievement Test

To determine the effectiveness of DI on learning science, the researcher conducted a learning achievement test with 5 marks each for multiple choice questions, true or false questions, fill in the blank questions, and short answer type questions. The total score of the test was 20 marks. (Refer Appendix F for Learning Achievement Test Questions). To analyse the learning achievement (Nutrition and healthy habits) of the research participants, the achievement test was conducted through pre-tests and post-tests. Pre-tests were conducted before the intervention and post-test after the intervention using the same set of test items that was used for the pre-test.

Learning achievement test items were framed following the guidelines of Bhutan Council for School Examination Assessment (BCSEA) and Bloom's Taxonomy.

3.3.3 Qualitative Instrument

Semi-Structured Interview

According to Dovetail (2023), a semi-structured interview is a qualitative research method used to gain an in-depth understanding of the respondent's feelings and beliefs on specific topics as (George, 2023) it relies on asking questions within a predetermined thematic framework. This approach provides an ideal framework for obtaining open-ended data and insights since this interview format encourages a two-way communication (Doyle, 2022).

In order to investigate the learning satisfaction of the participants towards the use of DI approach in learning science, the researcher conducted a face-to-face interview with each participant after the intervention of the strategy.

For the semi-structured interview, the researcher framed six questions based on two themes (interest and motivation and efficacy of the use of DI on student learning) (Refer Appendix H for Semi-structured Interview questions). The researcher included 29 research participants for the interview and they were given the option to respond in the language of their choice. Each student's response was recorded in audio during the interview and later the researcher translated and transcribed responses in English. The researcher analysed the data using different themes.

3.4 Validity and Reliability of Research Instruments

3.4.1 Content Validity

Validity refers to how accurately a method measures what it is intended to measured (Middleton, 2023). Stewart (n.d.) posits that the validity in research speaks to the degree to which a study accurately reflects or assesses the specific concepts that the researcher is attempting to measure or understand. Thus, it is about ensuring that the study investigates what it purports to investigate. The validity of the research

instruments, lesson plans, test items, and semi-structured interview questions were validated by 3 experts, a Professor from Rangsit University, Thailand, and two experienced Science tutors from Bhutan (Refer Appendix C for Expert's details). The validity of the instruments was done using the Item Objective Congruence Index (IOC). The IOC of the instruments were calculated to see whether the items were aligned with the learning objectives. The result of the IOC index ranges from -1 to +1 as described below:

If the rating is 1, the item clearly matches the given objectives.

0, means the item is uncertain, not sure if it meets the objectives or not.

-1, tells us that the item clearly does not match the objectives.

IOC was calculated by applying the formula: IOC= $\sum\frac{r}{n}$, where 'r' is the score of individual expert's ratings and 'n' is the number of experts. The value of the test item between 0.67 and 1.00 was considered accurate and acceptable where as a value below 0.67 indicated that the item needs to be rephrased as per the expert's suggestions and feedback. In this study, all instruments were validated with the score between 0.67 to 1.00. (Refer Appendix E for IOC of lesson plans, Appendix G for IOC of learning achievement test, and Appendix I for IOC of semi-structured interview questions).

3.4.2 Reliability

According to Middleton (2023), reliability refers to how consistently a method measures something. In other words, reliability reflects the degree to which a measurement instrument produces consistent results when applied repeatedly to the same phenomenon, under the same conditions (Jansen, 2023). To check the reliability of the learning achievement test questions, the researcher conducted a pilot test consisting of 5 marks each for multiple choice questions, true or false questions, fill in the blank questions, and short answer type questions. The test was conducted with total of 20 marks with grade 6 students (34 students) of the same school. Kuder-Richardson formula (KR-20) was used to check the reliability coefficient of the learning outcome of the test. The KR-20 coefficient for the instruments should be

equal to or greater than 0.70 if the instruments are to be reliable. In this study, learning achievement test questions were validated and were reliable with the score of 0.80. (Refer Appendix J for reliability test scores of learning achievement test).

3.5 Data Collection Procedures

According to Suthar (2024), data collection is the systematic process of gathering, measuring, and recording data for research, analysis, or decision-making. It involves collecting data from various sources, such as surveys, interviews, observations, experiments, documents, or existing databases, to obtain relevant and reliable information. To collect data for the study, the researcher considered the following procedures:

3.5.1 Ethical Consideration

3.5.1.1 Approval

The researcher was granted approval by the Research and Development Institute of the Rangsit University, Thailand, followed by an approval from the Ministry of Education and Skill Development (MoESD) in Bhutan. The researcher further sought permission from the Principal and the concerned subject teacher of the research school in Paro. (Refer Appendix A for the letters of Approval). Since, the research participants were below the legal age, the researcher requested the parents/guardian to read and understand the content of the consent letter before signing it. This was done to avoid violation of the rights of the participants during the study. (Refer Appendix B for the Consent Letters). Therefore, the researcher sought all necessary approvals before the actual data collection procedure.

3.5.1.2 Anonymity and Confidentiality of the participants

Throughout the course of study, researcher kept participants' details, views and opinions confidential and anonymous by using numbers instead of the name. The participants were referred as B501, B502, B503 and so on.

3.6 Data Analysis

The researcher analyzed the data in two areas in line with two research objectives. The first data was analyzed on learning achievement and second analyzed on learning satisfaction of the participants. The researcher collected data for learning achievement by conducting pre-test and post-test with students. Similarly, the data for learning satisfaction of the research participants was collected from semi-structured interviews.

3.6.1 Analysis for learning achievement

The comparison between pre-test and post-test of the sample group were done using paired sample t-test to determine the effectiveness of using differentiated instruction on learning science in grade 5 classroom. A comparative statistical analysis was drawn by computing the mean, standard deviation, and significant value of the pretest and posttest (Refer Appendix K).

3.6.2 Analysis for learning satisfaction

The researcher conducted semi-structured interview with each student to better understand the students' satisfaction towards the approach used. To analyze the data, the researcher developed themes and patterns through coding system. After utilizing the thematic analysis approach, the data collected through semi-structured interviews were evaluated and stated.

CHAPTER 4

RESULT AND DATA ANALYSIS

In this chapter, the researcher highlights the findings of the study on 'The Effectiveness of Using Differentiated Instruction on Science Learning Achievement for Grade 5 Bhutanese Students'. The research findings were derived from the following research instruments including learning achievement test (Pre-test and Post-test design), Lesson plans and Semi-structured interview questions. Comparative analysis and content analysis technique were undertaken to find out the extent of learning achievement and learning satisfaction.

In this chapter finding from the data are presented as follows:

4.1 Data Analysis of Learning Achievement

4.2 Data Analysis of Students' Learning Satisfaction

The first objective of the study was to find out to what extent DI approach improved students' learning achievement of grade 5 students in science. A comparative statistical analysis was done using one sample t-test by comparing in terms of mean, standard deviation and significant value. The comparison was done 'within the group 'by comparing the pre-test and the post-test scores of the sample group. The inferential statistics t-test with $p<0.05$ level of significance, mean, and standard deviation were used to gather the results.

4.1 Data Analysis of Learning Achievement

The scores of pre-test and post-test of the sample group are presented below in table 4.1. It was evident that the performances of the students were remarkably higher in the post-test scores than the pre-test scores. The scores of the pre-test ranged 4.5 to 13.5 with two participants scoring 13.5 and one participant scoring 4.5. The

post-test scores were remarkably higher with a maximum score of 19.5 and minimum of 7. The student with the greatest improvement was B506 and B507 who scored 10.5 marks higher than the pretest. This shows highest improvement percentage as 52.5%.

Student B514 showed the lowest improvement, scoring only 0.5 marks higher in the posttest than the pretest with the improvement percentage of 2.5 %. It is important to note that every participant showed a notable improvement in the post-test scores as shown in the table below.

Table 4.1 Comparison of Pre-test and Post-test

Student Code	Pre-test (20)	Post-test (20)	Improved Score	Improved percentage
B501	11.5	16.5	5	25 %
B502	9	17.5	8.5	42.5 %
B503	8.5	12.5	4	20 %
B504	9.5	15.5	6	30 %
B505	6	10	4	20 %
B506	6.5	17	10.5	52.5 %
B507	5.5	16	10.5	52.5 %
B508	7.5	13	5.5	27.5 %
B509	13.5	18	4.5	22.5 %
B510	7	13	6	30 %
B511	7	8.5	1.5	7.5 %
B512	5	9.5	4.5	22.5 %
B513	6.5	15	8.5	42.5 %
B514	6.5	7	0.5	2.5 %
B515	11.5	15	3.5	17.5 %
B516	13.5	18	4.5	22.5 %
B517	11	16	5	25 %
B518	4.5	14.5	10	50 %
B519	10	14.5	4.5	22.5 %
B520	6	11	5	25 %
B521	8.5	15.5	7	35 %

Table 4.1 Comparison of Pre-test and Post-test (Cont.)

Student Code	Pre-test (20)	Post-test (20)	Improved Score	Improved percentage
B522	10.5	14	3.5	17.5 %
B523	9.5	16	6.5	32.5 %
B524	12.5	16	3.5	17.5 %
B525	5.5	13.5	8	40 %
B526	9	14	5	25 %
B527	10.5	14	3.5	17.5 %
B528	8.5	15.5	7	35 %
B529	7.5	15	7.5	37.5 %
B530	9.5	19.5	10	50 %
Mean	8.5	14.4	5.8	29 %

Table 4.2 Sample T-Test Analysis

Group	Pretest		Posttest		Mean Difference	t	Sig. p-Value
Sample Group	Mean	SD	Mean	SD	14.37-8.58 =5.79	-12.413	.01
	8.58	2.50	14.37	2.88			
Significant level (p): <0.05 significant							

Table 4.2 shows the result of the descriptive statiscal analysis for the sample group's achievement test scores. The mean score for the pretest and posttest were 8.58 and 14.37 respectively. It is evident from the results presented in Table 4.2 that the posttest mean score (14.37) of the group higher than that of the pretest mean score (8.58) with a mean difference of 5.79. The greater mean score in the posttest indicated the efficiency and effectiveness of using DI on science learning. A paired sample t-test shown in Table 4.2 indicated the significance value of .01 indicating the test's significance. The standard deviation of the pretest and posttest were 2.50 and 2.88 as shown in Table 4.2.

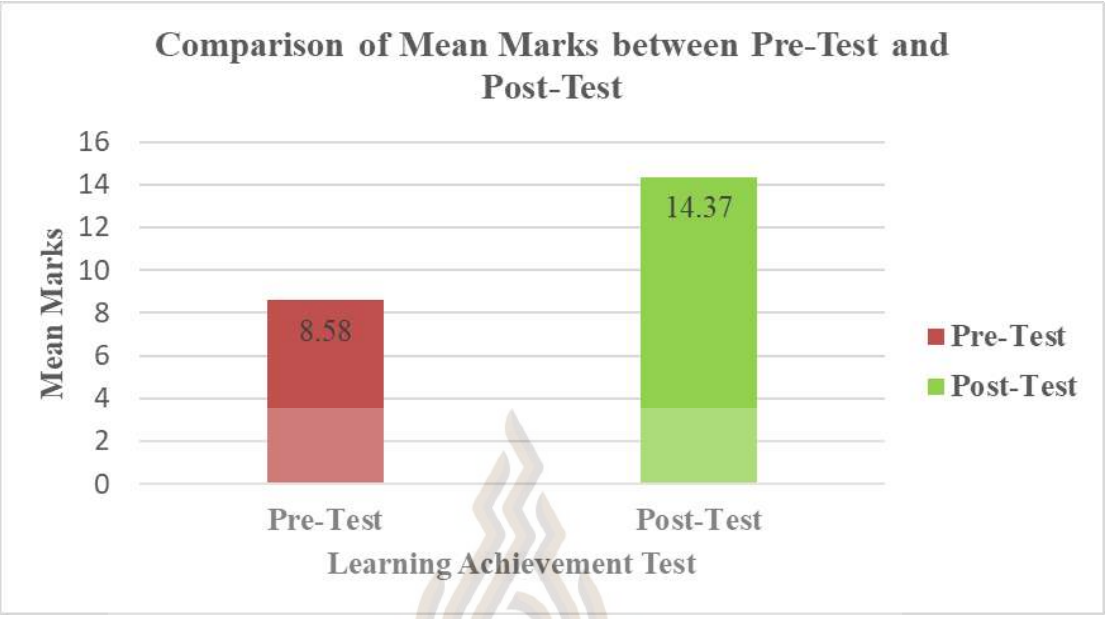


Figure 4.1 Pre-test and Post-test Mean Comparison

The mean scores after the intervention were much higher than the scores before the intervention. This shows that the participants' learning achievement before the intervention was significantly lower than after the intervention. Figure 4.1 clearly shows that the average score after the intervention was higher than the average score before the intervention. Overall, these results indicated that learning through the use of DI approach helped grade 5 Bhutanese students science learning. Therefore, it appears that the first research question was answered positively, and the first research objective and hypothesis were supported too.

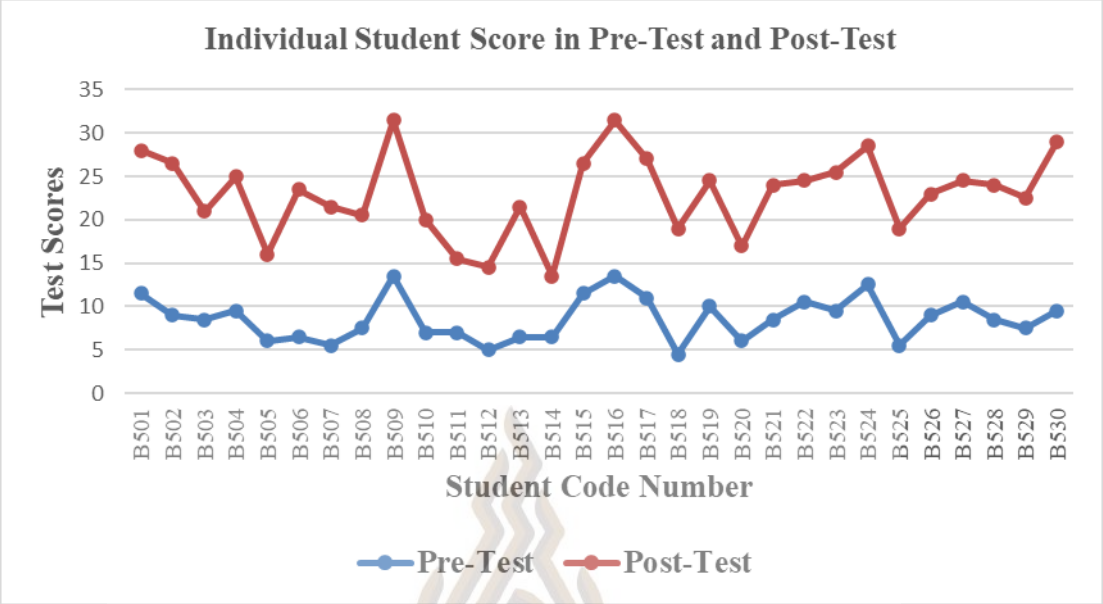


Figure 4.2 Individual Student Score in Pre-test and Post-test

The Figure 4.2 shows the score of each student both in pre-test and post-test. Additionally, it also presents an individual student's score difference in the pre-test and post-test. The post-test scores of an individual student drawn in red line evidently proved that every participant had significantly improved in their scores compared to the pre-test scores drawn in blue line.

4.2 Data Analysis of Students' Learning Satisfaction

The qualitative data was collected through semi-structured interview to further respond the second objective of the study. The second objective of the study was to investigate whether the use of differentiated instruction in science would increase students' learning satisfaction or not. To investigate, the researcher conducted interviews with 29 students from sample group upon the completion of teaching. From 30 sample students, one student refused to interview citing his/her own disinterest for the interview. Thereby, as per the research ethics, the researcher has considered his/her reason and did not include this person in the interview. To keep the privacy of the research participants, the researcher used the student code during the interview. The students were allowed to speak in whichever language they felt in, in sharing their

opinion on the study. The researcher recorded every detail that the student has shared during the interview. Later, the recorded responses were translated and transcribed to English. This helped the researcher in analyzing the data and drawing meaningful conclusion about how the use of DI on science learning influenced and satisfied their learning experiences.

The data were studied, analyzed, and interpreted into themes based on the research objectives and questions of the study. The data from the students' interview were analyzed under two broad themes: Part I: interest and motivation, Part II: efficacy of differentiated instruction on student's learning which were further divided into four sub themes: 1) Past Experiences, 2) Fun Learning and Satisfaction, 3) Convenience and Flexibility, 4) Preferred mode of Learning.

4.2.1 Interest and Motivation

Past Experiences

Hundred percent of the students shared that it was their first-time learning science this way. Nobody had experienced DI learning approach in the past. In most classes, the variation in learning and teaching method was limited. This as a result hindered students learning and interest towards learning. The intervention introduced a more interactive and engaging approach towards learning Science. The students were decisive, responsible and cooperative enough towards choosing their own mode of learning. It has helped them learn and understand the content taught to their own capacity. This way it fostered students critical thinking skills and independent learning.

> "No, I have not experienced this type of learning and teaching strategy." (B502, personal communication, May 30, 2024).

> "No, I was never taught or learned through this type of learning approach and styles." (B505, personal communication, May 30, 2024).

"In the past, most activities are to do individually which hampered me by not getting to discuss with friends and could not do well in Science." (B515, personal communication, May 30, 2024).

Fun Learning and Satisfaction

Learning Science became fun with various learning modalities in place. Students had shared that learning Science by engaging in different activities, learning materials and working modalities has made their learning interesting and easier. By adopting a student-centered class, students had the flexibility to choose their way of learning. Teaching and learning were not just restricted to chalk and talk, instead students had the avenue to show case their own capabilities and learn at the same time. Students enjoyed the lessons as it was based on their readiness, interest/preferences, flexible grouping and learning style. These multiple methods to learning had not just made learning engaging and meaningful but also created a memorable learning atmosphere since it was their first time learning this way.

"The learning was interesting and happy; I am satisfied with my own learning." (B509, personal communication, May 30, 2024).

"It was interesting and fun way of learning. I was happy to participate in various group activities and learn together." (B522, personal communication, May 30, 2024).

"I felt that I have learned well in science class. It was easier to learn faster as there was flexibility to choose how to learn. It was interesting and fun and I am satisfied." (B523, personal communication, 2024).

"I felt my learning has improved a little so I feel happy and good. This is because I am not good at Science and less interested studying Science but now my interest towards attending science class has improved." (B512, personal communication, May 30, 2024).

"I felt exciting as the learning was fun as well as I could learned whatever taught in the class." (B527, personal communication, May 30, 2024).

4.2.2 Efficacy of differentiated instruction on student's learning

Convenience and Flexibility

A collective analysis of participants' interview on efficacy of DI on student's learning has displayed high level of satisfaction. Most of the participants revealed that DI on Science learning was convenient and flexible. Participants expressed that this way of learning has not only made them learn the content taught but also honed the skills like decision making and taking responsibilities of their learning. Additionally, participants have also confessed that getting a platform to learn as per their readiness, learning style, and interest was of great benefit to them. The main reason for this response was, it allowed them to choose their way of learning or adopt and adapt to learning styles that best suited their personalities. It has provided them with the avenue to choose their personalized mode of learning.

"I got opportunity to choose my partner to work since I am more comfortable working with my own gender and best friend rather than to work with another gender." (B518, personal communication, May 30, 2024).

"Working as per our learning style was interesting since I could choose my way of learning. I have chosen to work in visual group since I like to learn visually and I am good in drawing and interpreting diagrams and illustrations." (B519, personal communication, May 30, 2024).

"Learning was convenient and flexible without much stress. Learning was more comfortable as I got to learn according to my learning style. I worked in auditory group and prepared speech which we delivered to whole class later. For me learning is better through discussion and getting different ideas from

group mates. I did not join visual group as I am not interested in drawing or diagrams." (B520, personal communication, May 30, 2024).

"Yes, the learning was convenient and I could learn better. In the past, most activities are to be done individually or groups but we don't get much flexibility in working modalities. I preferred working as per the readiness, since all my friends are similar to my ability and could work and discuss well." (B515, personal communication, May 30, 2024).

From the above responses quoted, it is learnt that almost all the students felt learning Science through DI was convenient and flexible. This mode of learning and teaching has further enhanced their learning and retention.

Preferred mode of Learning

According to the responses shared through the interview, the participants enjoyed Science lessons and they were satisfied with what they did and learnt. Therefore, learning Science through DI was meaningful as it focused on a student-centered classroom. To find out more on their future preferences or desire to learn through DI, the question was asked: Would you prefer to learn other subjects through the differentiated instruction approach? Why? All the participants gave positive response and some of the common statements are quoted below.

"Yes, because in DI lesson learning can happen through different mediums and use and get different ideas." (B501, personal communication, May 30, 2024).

"Yes, I would prefer learning other subjects too through DI since with this strategy learning becomes fun and engaging. It helped learn better as I got the choice to choose my learning modalities." (B506, personal communication, May 30, 2024).

"Yes, because we can learn well like I did in this science class. The motivation to go to the class and learn will be enhanced. For example: Previously, I had less interest learning Science but after attending this this class my interest towards learning Science has increased. The different teaching style used has been very helpful for me to learn and understand the lesson taught." (B510, personal communication, May 30, 2024).

"Yes, because learning through different modalities helps in understanding, participating and building confidence in the classroom participation." (B511, personal communication, May 30, 2024).

"Yes, because learning other subjects like I did in this science will help me improve my learning status in other subjects too." (B512, personal communication, May 30, 2024).

It was clear from the responses given above that they enjoyed learning Science through DI. All of the participants experienced new learning environments that were enjoyable, engaging and satisfying. The learning was meaningful and to their interest as it was a student-centered approach where participants had an avenue to choose their way of learning from the given flexible choices. It was their first-time experiencing this mode of learning. Besides classroom learning, the participants were also able to learn life skills like decision making, taking their own responsibilities in learning, building confidence and leadership roles. This in all has boosted and promoted positive attitude towards learning Science.

In summary, this chapter discussed the details of data analysis report to investigate, "To what extent does learning Science through differentiated instruction improve students' achievement and their perception towards differentiated instruction approach in learning Science?" The quantitative data analysis of the pre-test and the post-test revealed that the participants experienced significant levels of learning achievement in learning Science through the use of DI learning approach. The score

differences obtained after the treatment clearly signified their improvement in the learning achievement of the sample participants.

The data analysis obtained from the responses of semi-structured interview showed positive perception towards the use of DI on learning Science. Thereby, the analysis of the achievement tests and the semi-structured interview questions showed a significant result towards using DI approach as an applicable way of learning Science.

CHAPTER 5

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

This chapter explains and elaborates on the findings of the research. It is followed by discussions of the findings and recommendations for future studies and research to enhance the learning process in general and Science instruction in particular.

5.1 Conclusion

The two questions below justified the research objectives and it helped to contextualize the subsequent analysis.

1) Would there be any significant improvement on grade 5 Bhutanese students' learning achievement in Science after using differentiated instruction?

2) Would there be learning satisfaction after using differentiated instruction in learning Science?

Pre-test and post-test results from learning achievement tests and information from the semi-structured interview were used to gather quantitative and qualitative information to address the questions raised above. These were later examined to draw additional conclusions from the research.

5.1.1 The Result of the Learning Achievement Analysis

To answer the first research question, the researcher used the results of the pre-test and post-test. The main intention for this question was to check whether using differentiated instruction would have any significant improvement on grade 5 Bhutanese students' Science learning achievement. The pre-test and post-test were conducted with

the research participants before and after using differentiated instruction on Science learning.

To compare the levels of achievement between the pre-test and post-test, a paired sample t-test was used in a comparative statistical analysis within the sample group. The mean score for the pre-test was 8.58 and the mean score for the post-test was 14.37 respectively with the mean difference of 5.79 as shown in table 4.2 in chapter 4. This evidently proved that students performed better in the post-test than the pre-test. And also, the significant value (P) of .01 which was lower than the significant value P< 0.05 clearly indicated that there was statistically a significant difference between the pre-test and post-test. Therefore, the first research question was answered as the learning achievement of grade 5 Bhutanese students in Science was improved after learning through the differentiated instruction. Thus, the significant difference in the mean score of the pre-test and post-test accordingly accepted the first hypothesis (H1) that stated; The learning achievement of grade 5 Bhutanese students would be significantly improved after using differentiated instruction in learning Science.

5.1.2 The Result of Semi-Structured Interview

To investigate the learning satisfaction of grade 5 Bhutanese students towards the use of DI in Science was the second research objective. To fulfill the second research objective, the researcher conducted semi-structured interviews with interested students. From the total sample students (n=30) one student had shown disinterest towards the interview citing his or her own reasons and rest 29 students were interviewed individually. All the responses generated were recorded, transcribed, and analyzed with the help of thematic analysis. On that account, the findings showed positive and high level of satisfaction towards the use of differentiated instruction on Science learning. The researcher reviewed and based semi-structured interview data on two broad themes and four sub-themes: Part I: Interest and Motivation 1) Past Experiences, 2) Fun Learning and Satisfaction and Part II: Efficacy of Differentiated Instruction on student's learning 3) Convenience and Flexibility, 4) Preferred mode of Learning.

Every participant noted that they were experiencing Science learning in this manner for the first time. None had encountered the DI approach before. In previous classes, teaching and learning methods were generally uniform. The intervention introduced a more interactive and engaging approach to studying Science. Students reported that learning Science had become enjoyable with diverse learning methods available. They also expressed that engaging in various activities and using different learning materials and methods had made learning both interesting and easier.

By adopting a student-centered approach, students had the freedom to choose how they wanted to learn. Teaching and learning went beyond traditional methods to include opportunities for students to demonstrate their abilities while learning simultaneously. Students showed decisiveness, responsibility, and cooperation in selecting their preferred learning methods. They indicated that this approach helped them grasp and understand the content at their own pace, enhancing their critical thinking and independent learning skills.

The findings also indicated that using multiple learning methods not only made learning more engaging and meaningful but also created a memorable learning environment, especially since it was their first exposure to this style of learning. Students were able to tailor their learning experience based on their readiness, interests, preferred groupings, and learning styles.

An overall analysis of participant interviews regarding the effectiveness of DI on student learning revealed high levels of satisfaction. Most participants found that DI in Science learning was convenient and flexible. They appreciated the opportunity to learn according to their readiness, learning style, and interests, which they found highly beneficial. The ability to choose their preferred learning style or adapt to styles that suited their personalities was particularly valued. All participants expressed a preference for learning in this way across other subjects as well.

Consequently, the researcher would like to conclude that the use of DI had significantly increased the satisfaction of grade 5 Bhutanese students in learning Science, thereby confirming the second hypothesis (H2) that predicted enhanced learning satisfaction among these students following the implementation of differentiated instruction in Science learning.

5.2 Discussion

The study revealed that the use of differentiated instruction on Science learning achievement for grade 5 Bhutanese students was effective and they had exhibited positive learning satisfaction towards the approach used. The findings are presented in detail to answer the research questions proposed in the study.

5.2.1 Students' Learning Achievement

According to the study, using DI helped grade 5 Bhutanese students in learning Science effectively. The significant mean difference of 5.79 from pretest and posttest has clearly revealed the improvement in learning achievement. The significant p-value of .01 has indicated that differentiated instruction helped most students perform better in posttest than the pretest. These results also signified that the use of differentiated instruction had positive impact on students' understanding the concept taught and their memory retention. This suggests that incorporating DI into learning and teaching methods can be an effective tool.

From the findings from the analysis of students' learning achievement data, it was found that all the students performed better after the use of DI. This is in relation to the study carried out by Loreman (2017) stating that differentiation focuses on optimizing learning and learning conditions. Similarly, the study results by Magableh and Abdullah (2020) reported that implementing differentiated teaching in a mixed-ability classroom reduced students' diversity to be more homogenous.

As per the findings from the interview, most of the students responded that they enjoyed the lesson as it was flexible and a convenient way of learning. They also disclosed that learning through discussion, learning by doing, and the opportunity to share their learning during and after the lesson was more meaningful. The findings of study are in line with Tomlinson (2001). She stated that effective differentiated classrooms include purposeful student movement and some purposeful student talking. While it is true that differentiated instruction offers several avenues to learning, it does not assume a separate level for each learner. This finding is further supported by the study conducted by Tulbure (2011), validating that with DI, students are at the center of the teaching process, their needs and preferred ways of learning are met and their success is assured.

This study has shown significant effectiveness of using DI on learning Science for grade 5 Bhutanese students, however one student's performance difference in pretest and posttest was not much significant with the improvement score of 0.5 marks. This posed some questions to the researcher about the effectiveness of the strategy used. Nevertheless, all of the students showed improvement after the treatment, whereby two students scoring very well with the improvement score of 10.5 marks respectively. This signified that using DI helped students learning achievement. With variation in improvement score for some students, it is difficult to determine and state that using DI is always beneficial to students' learning. The educator needed more time to understand each student and their differences as Papanthymou and Maria (2022) sated that the success of DI depended on how well teachers were prepared to assess students' needs and adjust their instructional approach to provide the appropriate instructional context.

Thus, these findings concluded that improvement in students' learning achievement could be attributed to the use of DI in their learning. The strategy used has made their learning more convenient, understandable and meaningful. Likewise, Alsalhi et al. (2021) posited that in DI classroom all students are involved in substantial and meaningful work or tasks. Therefore, the study had further proven that using DI can improve the learning achievement of students in Science.

5.2.2 Students' Learning Satisfaction

Secondly, this study was targeted to find the grade 5 Bhutanese Students satisfaction level towards the use of differentiated instruction in Science learning. The semi-structured interview with a set of 6 questions were responded by the participants (n=29). The findings from the interview data revealed that using differentiated instruction in learning Science as fun, satisfactory learning, convenient and catered to their personalized mode of learning. The researcher was convinced that this change in mode of learning has motivated students in learning Science and students were inspired to learn in this way across other subjects too. Flexibility in learning method where students could choose their own style of learning has made learning more engaging and constructive. The students have also expressed that, it was a new learning environment that they were experiencing for the first time.

One of the prominent responses identified from the students was the personalized mode of learning. The semi-structure interview data revealed that most of the students enjoyed lessons as it provided them the freedom to choose their way of learning. As they could exercise their own freedom to their own way of learning, the learning became easier, effective and productive and aided with better memory retention. Thus, properly designed instructional activities paired with appropriate instructional materials aligned with each learner's need and preferences contributed to higher level of learning satisfaction. This result is parallel with the findings of Lhaden (2023). The learner-centered approaches, such as personalized and differentiated instruction can enhance learners' sense of satisfaction and engagement. Similarly, Liou, Cheng, Chu, Chang, and Liu (2023) posited that differentiated instruction can provide students with various opportunities to learn and meet the learning needs of students with different academic abilities and strengths, which may be a solution.

In this study, lessons were based on different grouping methods and instructional activities as per the DI philosophy. The students expressed their likeability while participating in the various activities across the lessons. According to the findings, most of them enjoyed the first, second and fourth lessons. These lessons

activities were based on the learner's readiness, interest/ preferences and learning style. This way of learning saved their time and made learning easier as some of the students preferred working with same ability members, and of the same gender. "I got opportunity to choose my partner to work since I am more comfortable working with my own gender and best friend rather than to work with another gender." (B518, personal communication). The findings have shown that learning as per their learning style was more meaningful as it helped them effortlessly as per their preferred way of learning (Learning through: visual, discussion and doing). Also, the students have exhibited positive attitude towards completing the given activity as there was freedom to choose any 3 questions out of the 4. These indicates that the researcher has implemented differentiated instruction in the classroom as it aligns with what is stated by Abutayeh (2022); The significance of implementing differentiated instruction lies in addressing the unique needs of learners, while also accommodating diverse learning methods and patterns through varied approaches and styles.

Besides content learning, students were able to learn life skill lessons like building confidence, cooperative skills and taking responsibilities of their action. This mode of learning could also help them hone their skills and the interest. In DI classroom, instructional activities were all based on their choice (learner-centered), which made them to be responsible of their own choice and completing the given task. The students could boost and build their confidence as every learning episode was followed up by presentation of their learning to the whole class. Basically, the heart of the DI classroom was based on Learning by doing where all the learning activities were hands-on practice. The learning became more concrete than abstract knowledge. This in a way, helped students understand the concepts taught faster by connecting to the real-life situations. Thus, this mode of learning fulfilled one of the guiding principles of Science Curriculum Framework of Bhutan (2022). Learning is, therefore, something that learners do, not something that is done to them. 'Hands-on' activities are essential throughout for a good science education.

Therefore, using differentiated instruction in learning Science created new and diverse learning environments. Throughout the learning process, students were receptive of the different learning modes and actively participated in learning. The implementation of DI in the classroom instruction provided students with rich and fun experiences that are convenient, flexible and satisfying learning opportunities, irrespective of their academic status or stand in the community.

5.3 Recommendations

Based on the findings, this study demonstrated that DI customized to students' readiness, interest, and learning style improved their Science learning achievement and enhanced satisfactions towards the approach used. Therefore, based on the findings of the study, following are the set of recommendations. The primary goal of the recommendations is to assist educators and future researchers in successfully incorporating differentiated instruction into Science classroom teaching. This approach aims to improve teaching and learning outcomes in Science, as well as to cultivate a positive attitude towards the subject, which can extend to other disciplines as well.

5.3.1 Recommendations for Practice

1) The Science lesson instruction on the topic Nutrition and healthy habits using differentiated instruction have been beneficial on students' learning achievement. The finding of this study revealed that the posttest scores were higher than the pretest. Therefore, the use of differentiated instruction in daily classroom teaching is highly recommended.

2) The classroom instruction using DI can be extended across other disciplines/ primary school subjects like English, Mathematics, Dzongkha, and Social Studies. However, the teacher should be proactive and school administrators must ensure adequate provision of resources, and overall be supportive. Also, the curriculum should be thinned down and precise and there should be a separate specific differentiated curriculum if possible.

3) The study also suggests that the Ministry of Education and Skill Development (MoESD) and school administrators prioritize the use of DI and offer professional development to teachers. This training should aim to ensure teachers are well-equipped to implement this approach effectively and enhance classroom instruction beyond traditional methods.

5.3.2 Recommendations for Future Research

Considering some of the limitations of the study, the researcher would like to recommend the following points for the future researchers in this field.

1) While DI positively influences students' Science learning outcomes, this study is constrained by a small sample size (30 students) and a brief implementation period (1 month) for the strategy. Therefore, the researcher suggests employing the differentiated instruction approach over extended durations and with larger participant groups.

2) Due to the prescribed curriculum and limited time, the study was carried out using differentiated instruction only in process and the product (learning activity and at lesson closure) avenues. For further study, the future researcher could differentiate lessons based on whole DI elements that include content, process and product areas too.

3) To further study the effectiveness of using DI on students learning achievement, future researchers could consider to basing their research on a comparative study analysis (one class teaching using DI (experimental group) and other class being taught without the DI treatment (controlled group). In that case, the researcher can gauge the effectiveness of the strategy implemented.

4) Since there have been limited studies in Bhutan examining the use of DI in classroom teaching, the researcher suggests that another study with this specific focus should be undertaken.

In conclusion, using DI has proven to be an effective and engaging approach to teach diverse students in today's classroom scenario, especially in the field of teaching and learning Science. Through the analysis of students' learning achievement

test and responses from the semi-structured interview, using DI in learning Science was found to be inclusive, engaging, and a meaningful way of learning. Although the researcher found that the implementation of DI had a positive impact on students' learning and attitude towards the strategy used, there are wider fields to study and research in future on this topic. Therefore, DI approach could be one of the important approaches to further study and investigate for the overall improvement of instructional strategies in schools to have a better impact on students' overall learning.

REFERENCES

Abutayeh, K. (2022). Jordanian Science Teachers' Perspectives on Obstacles of Differentiated Instruction. *İlköğretim Online, 20*(2), 67-73. doi:10.17051/ilkonline.2021.02.12

Aina, J. K. (2013). Importance of Science Education to National Development and Problems Militating Against Its Development. *American Journal of Educational Research 2013, 1*(7), 225-229. doi:10.12691/education-1-7-2

Alhameedyeen, R. A. B. (2024). Exploring Faculty Perspectives on Implementing Differentiated Instruction. *International Journal of Education in Mathematics, Science and Technology, 12*(2), 318-833. https://doi.org/10.46328/ijemst.3964

Aliakbari, F., Parvin, N., Heidari, M., & Haghani, F. (2015). Learning theories application in nursing education. *National Library of Medicine*, *4*(2), 3-11. doi:10.4103/2277-9531.151867

Alsalhi, N. R., Abdelrahman, R., Abdelkader, A. F. I., AI-Yatim, S. S., Habboush, M., & Qawasmi, A. A. (2021). Impact of using the differentiated instruction (DI) strategy on student achievement in an intermediate stage science course. *International Journal of Emerging Technologies in Learning (iJET), 16*(11), 25–45. doi:10.3991/ijet.v16i11.22303

AM, M. A., Hadi, S., & Istiyono, E. (2023). Trend research mapping of differentiated instruction: A bibliometric analysis. *Journal of Pedagogical Research, 7*(3), 194-210. https://doi.org/10.33902/JPR.202320544

Amoakwah, A., & Donkoh, S. (2023). Basic School Teachers' Knowledge and use of Differentiated Instruction. *European Journal of Education Studies, 10*(10), 162-177. doi:10.46827/ejes.v10i10.5004

Arun, A., & Singaravelu, G. (2018). Brain-based Learning: A tool for Meaningful learning in the classroom (2018). *International Journal of Research, 7*(IX), 766-771. Retrieved from https://www.researchgate.net/publication/328138396_Brain-Based_Learning_A_Tool_for_Meaningful_learning_in_the_Classroom

REFERENCES (CONT.)

Bălaş Timar, D., & Moraru, R. (2012). Learning Theories - A Psychological Overview. *Agora Semestrial Journal*, *6*(1), 70-95. Retrieved from https://www.researchgate.net/publication/260713244_Learning_Theories_-_A_Psychological_Overview#:~:text=Learning%20theories%20are%20those%20that,of%20specific%20authors%20or%20schools

Bhutan Baccalaureate (BB). (2021). *Druk Gyalpo's Institute.* Retrieved from https://dgi.edu.bt/

Bhutan Council for School Examination and Assessment (BCSEA). (2019). *Education in Bhutan: findings from Bhutan's experience in PISA for Development.* Retrieved from earningportal.iiep.unesco.org/en/library/education-in-bhutan-findings-from-bhutans-experience-in-pisa-for-development#:~:text=Bhutanese%2015-year-olds%20performed,and%2045.1%25%20in%20scientific%20literacy

Chalermnirundorn, N. (2019). Multicultural education and classroom diversity. *St. Theresa Journal of Humanities and Social Sciences, 5*(1), 42-54.

Darra, M., & Kanellopoulou, E. M. (2019). The Implementation of the Differentiated Instruction in Higher Education: A Research Review. *International Journal of Education, 11*(3), 151-172. doi:10.5296/ije.v11i3.15307

Das, N., Amrita., & Singh, N. (2014). Importance of Science in School Curriculum. *Weschool Knowledge Builder- The Nationl Journal, 2*, 15-18.

Dawadi, S., Shrestha, S., & Giri, R. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Studies in Education, 2*(2), 25-36. https://doi.org/10.46809/jpse.v2i2.20

DiscoverPhDs. (2020). *What is research instrument?* Retrieved from https://www.discoverphds.com/blog/research-instrument

Dorji, K., Jatsho, S., & Choden, P. (2022). Issues of Bhutanese Science Education: A view from the exploratory study. *RABSEL: the CERD Educational Journal*, *22*(2), 1-21. http//doi.org/10.17102/rabsel.22.2.5

Dovetail Editorial Team. (2023). *What is semi-structured interview?* Retrieved from https://dovetail.com/research/semi-structured-interview/

REFERENCES (CONT.)

Doyle, A. (2022). *What is a semi-structured interview?: Definitions & examples of semi-structured interview.* Retrieved from https://www.thebalancemoney.com/what-is-a-semi-structured-interview-2061632

Doyle, L., Brady, A. M., & Byrne, G. (2009). An overview of mix-method research. *Journal of Research in Nursing, 14*(2), 175–185. doi:10.1177/1744987108093962

Dwayne, M. W. (2015). *Differentiated instruction in the science classroom: Student perception, Engagement, and Learning* (Master thesis). Retrieved from https://scholarworks.montana.edu/xmlui/bitstream/handle/1/9299/WhiteD0815.pdf;sequence=

Enosh, G., Tzafrir, S. S., & Stolovy, T. (2014). The development of client violence questionnaire (CVQ). *Journal of Mixed Methods Research, 9*(3), 273–290. https://doi.org/10.1177/1558689814525263

Fensham, P. J. (2008). *Science Education Policy Making: Eleven emerging issues*. Brazil: United Nations Educational, Scientific and Cultural Organization.

Gangi, S. (2011). *Differentiating Instruction Using Multiple Intelligences in the Elementary School Classroom: A Literature Review.* Retrieved from https://www2.uwstout.edu/content/lib/thesis/2011/2011gangis.pdf

Gardner, H. (2011). *Frames of Mind: The Theory of Multiple Intelligences*. Retrieved from https://www.amazon.com/Frames-Mind-Theory-MultipleIntelligences/dp/0465024335?asin=0465024335&revisionId=&format=4&depth=1

Geel, M.V., Keuning, T., Frèrejean, J., Dolmans, D., Merriënboer, J.V., & Visscher, A. J. (2019). Capturing the complexity of differentiated instruction. *An International Journal of Research, Policy and Practice*, *30*(1), 51-67. https://doi.org/10.1080/09243453.2018.1539013

George, T. (2023). *Semi-structured interview/Definition, Guide & Examples. Scibber.* Retrieved from https://www.scribbr.com/methodology/semi-structuredinterview/

REFERENCES (CONT.)

Gheyssens, E., Griful-Freixenet, J., & Struyven, K. (2023). Differentiated Instruction as an Approach to Establish Effective Teaching in Inclusive Classrooms. In R. Maulana, M. Helms-Lorenz, & R. M. Klassen, (Eds.). *Effective Teaching Around the World*. Cham: Springer. https://doi.org/10.1007/978-3-031-31678-4_30

Gibson, L. (2013). Differentiated Instruction and Students with Learning Disabilities. In J. P. Bakken, F. E. Obiakor, & A. F. Rotatori, (Ed.). *Learning Disabilities: Identification, Assessment, and Instruction of Students with LD* (Advances in Special Education, Vol. 24) (pp. 161-183). Leeds: Emerald Group Publishing Limited. https://doi.org/10.1108/S0270-4013(2013)0000024012

Gyamtso, D. C., & Maxwell, T. W. (2012). Present Practices and Background to Teaching and Learning at the Royal University of Bhutan (RUB): A Pilot Study. *International Journal of Teaching and Learning in Higher Education, 24*, 65-75.

Hileman, A. N. (2009). *The impact of differentiation strategies on student achievement* (Master's thesis). Retrieved from https://scholarworks.uni.edu/grp/841

Jacobse, A. E., Meijer, A., Helms-Lorenz, M., & Maulana, R. (2019). Differentiated Instruction in Secondary Education: A Systematic Review of Research Evidence. *Frontiers in Psychology, 10*, 2366. https://doi.org/10.3389/fpsyg. 2019.02366

Jansen, D. (2023). *Validity and reliability in research: A language- explanation with examples.* Retrieved from https://gradcoach.com/validity-reliability-research/

Kado, Dorji, N., Dem, N., & Om, D. (2021). The effect of differentiated instruction on academic achievement of grade eleven students in the field of derivative in Bhutan. *International Journal of Social Sciences and Educational Studies*, *2*(1), 27-34. doi:10.53402/ijesss. v2i1.37

Kaptan, K., & Timurlenk, O. (2012). Challenges for science education. *Procedia- Social and Behavioural sciences, 51*(2012), 763-771. doi:10.1016/j.sbspro.2012.08.237

Katel, N. (2024). *More Board Exams and the growing academic pressure on Bhutanese students*. Retrieved from https://x.com/thebhutanese/status/ 1749354310134280338

REFERENCES (CONT.)

Khishfe, R. (2012). Relationship between nature of science understandings and argumentation skills: A role for counterargument and contextual factors. *Journal of Research in Science Teaching, 49*(4), 489–514. https://doi.org/10.1002/tea.21012.

Kiley, D. (2011). *Differentiated instruction in the secondary classroom: Analysis of the level of implementation and factors that influence practice* (Master's thesis). Retrieved from https://scholarworks.wmich.edu/dissertations/427

Koeze, P. A. (2007). *Differentiated instruction: The effect on student achievement in an elementary school* (Doctoral dissertation). Retrieved from https://commons.emich.edu/cgi/viewcontent.cgi?article=1030&context=theses

Letzel-Alt, V., & Pozas, M. (2023). *Differentiated instruction around the world: A Global Inclusive Sight.* Berlin: Humboldt-Universität zu Berlin, Professional School of Education. doi:10.31244/9783830997023

Lhaden, K. (2023). *The impacts of using visual images for mathematics achievement of grade Grade 4 Bhutanese Students* (Unpublished Master's thesis). Rangsit University, Thailand.

Lin, P.Y., Wu, W.C., & Yang, J.H. (2021). A QR code-based approach to differentiating the display of augmented reality content. *Applied Sciences, 11*(24), 11801. https://doi.org/10.3390/app112411801

Liou, S. R., Cheng, C. Y., Chu, T. P., Chang, C. H., & Liu, H. C. (2023). Effectiveness of differentiated instruction on learning outcomes and learning satisfaction in the evidence-based nursing course: Empirical research quantitative. *Nursing Open, 10*(10), 6794-6807. doi:10.1002/nop2.1926

Loreman, T. (2017). Pedagogy for Inclusive Education. *Oxford Research Encyclope-dias*. https://doi.org/10.1093/acrefore/9780190264093.013.148

Magableh, B. S., & Abdullah, A. (2020). On the Effectiveness of Differentiated Instruction in the Enhancement of Jordanian Students' Overall Achievement. *International Journal of Instruction, 13*(2), 534–548. https://doi.org/10.29333/iji.2020.13237a

REFERENCES (CONT.)

Magableh, I. S. I., & Abdullah, A. (2020). Effectiveness of Differentiated Instruction on Primary School Students' English Reading Comprehension Achievement. *International Journal of Learning, Teaching and Educational Research. 19*(3), 20-35. https://doi.org/10.26803/ijlter.19.3.2

Maxwell, J. A. (2016). Expanding the history and range of mixed methods research. *Journal of Mixed Methods Research, 10*(1), 12–27. https://doi.org/10.1177/1558689815571132

Meriyati, M., Sumianto, S., Nusraningrum, D., Cheriani, C., Guilin, X., Jiao, D. (2023). Optimizing the Use of Differentiated Instruction Strategies to Accommodate Diverse Student Needs. *Journal International Inspire Education Technology (JIIET), 2*(2), 65–75. https://doi.org/10.55849/jiiet.v2i2.455

Middleton, F. (2023). *Reliability vs Validity in Research/ Differences, types and Examples*. Retrieved from https://www.scribbr.com/methodology/reliability-vs-validity/

Ministry of Education. (2014). *Bhutan education blueprint 2014-2024*. Bhutan: Author.

Mukhalalati, B. A., & Taylor, A. (2019). Adult learning theories in context: A quick guide for healthcare professional educators. *Journal of Medical Education and Curricular Development*, *6*, 1–10. https://doi.org/10.1177/2382120519840332

Munro, J. (2012). *Effective strategies for implementing differentiated instruction*. Retrieved from https://research.acer.edu.au/cgi/viewcontent.cgi?article=1144&context=research_conference

Nair, S. S., & Prem, S.S. (2020). A Framework for Mixed-method Research. *Shanlax International Journal of Management, 8*(2), 45-53. https://doi.org/10.34293/management.v8i2.3220

National Statistical Bureau. (2023). *Statistical yearbook of Bhutan 2023.* Bhutan: Author.

REFERENCES (CONT.)

Osborne, J. (2007). Science Education for the Twenty First Century. *Eurasia Journal of Mathematics, Science & Technology Education, 3*(3), 173-184.

Papanthymou, A., & Maria, D. (2022). Teachers' Perceptions Regarding the Factors of Implementing Differentiated Instruction to Students with Learning Difficulties: Empirical Research in Primary Education. *International Journal of Learning and Development, 12*(3), 53-70. https://doi.org/10.5296/ijld.v12i3.20184

Pem, T. (2022). *The application of play-based learning for a science subject of grade Grade 5 Bhutanese Students* (Unpublished Master's thesis). Rangsit University, Thailand.

Ponmozhi, D., & Ezhili, N. (2023). A study on Effectiveness of Differentiated instruction on Higher Secondary School Student's Achievement in Mathematics. *International Journal of Advance Research and Innovative Ideas in Education, 9*(3), 1502-1505. Retrieved from https://www.researchgate.net/publication/372314954_A_STUDY_ON_EFFECTIVENESS_OF_DIFFERENTIATED_INSTRUCTION_ON_HIGHER_SECONDARY_SCHOOL_STUDENT'S_ACHIEVEMENT_IN_MATHEMATICS

Rabgay, T. (2018). Patters of Teacher-student verbal interaction in the tenth-grade biology class, Samtse District. *RABSEL: The CERD Educational Journal, 15*, 1-23.

Rabgay, T. (2021). *Action Research in Bhutan: Factors Influencing Bhutanese Secondary science Teachers' Collaborative Efforts* (Master's thesis). Retrieved from https://www.researchgate.net/publication/355940463_Action_Research_in_Bhutan_Factors_Influencing_Bhutanese_Secondary_Science_Teachers%27_Collaborative_Efforts

Ramakrishnan, J. (2018). Brain Based learning strategies. *International Journal of Innovative Research and Studies, 2*(5), 235-242. Retrieved from https://www.researchgate.net/publication/324704225

Royal Education Council. (2012). *Science curriculum framework PP-XII*. Bhutan: Author.

REFERENCES (CONT.)

Royal Education Council. (2016a). *Complete Bhutan National School Curriculum Conference 2016 report.* Bhutan: Author.

Royal Education Council. (2016b). *National School Curriculum Conference 2016: Rethinking Curriculum Report.* Bhutan: Author.

Royal Education Council. (2019). *Needs assessment on the differentiated curriculum in science and mathematics.* Bhutan: Author.

Royal Education Council. (2022). *Science curriculum framework PP-XII*. Bhutan: Author.

Safawi, S. S., & Akay, C. (2022). The effect of differentiated instruction approach on students' academic achievement and attitudes: A meta- analysis study. *Integrity Journal of Education and Training, 6*(6), 120-132. doi:10.31248/IJET2022.163

Scarparolo, G., & Subban, P. (2023). *Differentiation and differentiated instruction: A philosophy and pedagogical approach to inclusive teaching and responsive, effective instruction.* Retrieved from https://api.research-repository.uwa.edu.au/ws/portalfiles/portal/276018240/Differentiated_Instruction_Around_the_World_2023.pdf

SCISPACE. (2024). *What is Research Instrument?* Retrieved from https://typeset.io/questions/what-is-research-instrument-2ml5fdllto

Shabani, K. (2016). Applications of Vygitsky's sociocultural approach for teachers' professional development. *Cogent Education, 3*(1), 1-10. https://doi.org/10.1080/2331186X.2016.1252177

Singh, A. (2021). *Importance of Science Education Schools*. Retrieved from https://www.theasianschool.net/blog/importance-of-science-education-in-schools/

Stewart, L. (n.d). *What is significance of validity in research?* Retrieved from https://atlasti.com/research-hub/validity-in-research

Subban, P. (2006). Differentiated instruction: A research basis. *International Educational Journal, 7*(7), 935-947.

REFERENCES (CONT.)

Suthar, J. (2024). *Data Collection*. Retrieved from https://www.wallstreetmojo.com/data-collection/

Tajik, O., Noor, S., & Golzar, J. (2023). Investigating Differentiated Instruction and the Contributing Factors to Cater EFL Students' Needs at the Collegial Level. *Research square.* https://doi.org/10.21203/rs.3.rs-3513269/v1

Talian, A., & Mercado, F.M. (2023). Teachers' perspectives on the use of differentiated instruction for English language Teaching. *The Normal Lights. 17*(2), 2-29. doi:10.56278/tnl.v17i2.2152

Tenzin, W. (2023). The Journey of Bhutanese school curriculum: Evolution towards competency-based education. *Lodey Rabsel Consulting*. doi:10.13140/RG.2.2.27993.90728

Tenzin, W., & Maxwell, T. W. (2012). Primary Science Education in Bhutan: Development and Challenges. *International Journal of Science Education. 34*(3), 375-400. doi:10.1080/09500693.2011.626461

Tobin, R., & Tippett, C. D. (2013). Possibilities and potential barriers: Learning to plan for differentiated instruction in elementary science. *International Journal of Science and Mathematics Education, 12*(2), 423-443. https://doi.org/10.1007/s10763-013-9414-z

Toledo, F. L. (2023). Differentiated instruction for enhanced Students' Academic Performance in Science 10 (Physics). *International Journal of Multidisciplinary: Applied Business and Education Research, 4*(8), 2830-2846. http://dx.doi.org/10.11594/ijmaber.04.08.21

Tomlinson, C. A. (2000). *Differentiation of instruction in the elementary grades. ERIC Digest.* Retrieved from ERIC database. (ED443572)

Tomlinson, C. A. (2001). *How to differentiate instruction in mixed-ability classrooms*. Retrieved from https://rutamaestra.santillana.com.co/wp-content/uploads/2020/01/Classrooms-2nd-Edition-By-Carol-Ann-Tomlinson.pdf

Tomlinson, C. A. (2014). *The differentiated classroom; Responding to the needs of all learners.* Retrieved from https://rutamaestra.santillana.com.co/wp-content/uploads/2020/01/The-Differentiated-Classroom-Responding-to-the-Needs.pdf

REFERENCES (CONT.)

Trigueros, R. (2018). Lesson Plan Lesson Plan. In *English Language Teaching.* Retrieved from https://www.researchgate.net/publication/322988706_LESSON_PLAN_LESSON_PLAN

Tulbure, C. (2011). Differentiate instruction for preservice teachers: An experimental investigation. *Procedia—Social and Behavioral Sciences, 30*, 448-452. https://doi.org/10.1016/j.sbspro.2011.10.088

United Nations Educational, Scientific and Cultural Organization. (2017). *A guide for ensuring inclusion and equity in education*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000248254

Utha, K., Giri, K., Gurung, B., Giri, N., Krogh, L., Keller, H. D., . . . Keller, K. D. (2016). *Quality of school education in Bhutan: Case studies in the perspective of Gross National Happiness and assessment practices*. Retrieved from https://vbn.aau.dk/ws/portalfiles/portal/244108383/Quality_of_school_education_in_Bhutan_online.pdf

Vijayatheepan, R. (2023). *Science Education for all- A critical analysis*. Retrieved from https://www.researchgate.net/publication/376492345_Science_Education_for_All_-A_Critical_Analysis

Weselby, C. (2014). *What is Differentiated Instruction? Examples of How to Differentiate Instruction in the Classroom*. Retrieved from https://resilienteducator.com/classroom-resources/examples-of-differentiated-instruction/

Wilkinson, S., & McTiernan, L. (2020). *Mixed Mode Research: Reaching the right people in the right way to get the data you need*. Retrieved from https://www.ipsos.com/en/mixed-mode-research-reaching-right-people-right-way-get-data-you-need.

Yuen, M., Westwood, P., & Wong, G. (2005). Meeting the Needs of Students with Specific Learning Difficulties in the Mainstream Education System: Data from Primary School Teachers in Hong Kong. *International Journal of Special Education*, *20*(1), 67-76. Retrieved from https://files.eric.ed.gov/fulltext/EJ846528.pdf.

REFERENCES (CONT.)

Zen, A. (2021). *The Impact of Differentiated Learning Activities on Student Engagement and Motivation in the English Language Arts Classroom* (Master's thesis). Retrieved from https://red.mnstate.edu/thesis/611

APPENDICES

APPENDIX A

APPROVAL LETTER

RSU มหาวิทยาลัยรังสิต RANGSIT UNIVERSITY

มหาวิทยาลัยรังสิต
เมืองเอก ก.พหลโยธิน
จ.ปทุมธานี 12000

Rangsit University
Muang-Ake, Paholyothin Rd.
Pathumthani 12000, Thailand

T. (66) 2997 2200-30
F. (66) 2791 5757
E. info@rsu.ac.th

Director General

Department of School Education

Ministry of Education

Thimphu, Bhutan

Date: April 12, 2024

Subject: Request for Permission to Collect Data for Master of Education Thesis

Dear Sir, /Madam,

Master of Education Program in Curriculum and Instruction, Suryadhep Teachers College would like to request your permission for five Master of Education candidates to collect data for thesis in Bhutan in the period of May 3, 2024 to June 15, 2024. The details of the candidates are shown as follows:

Name	Research title	Research School
MISS CHIMI SELDEN	THE EFFECTIVENESS OF USING DIFFERENTIATED INSTRUCTION ON SCIENCE LEARNING ACHIEVEMENT FOR GRADE 5 BHUTANESE STUDENTS	Taju Primary School, Paro, Bhutan

Thank you for your kind consideration.

Truly yours,

Nipaporn Sakulwongs

Assistant Professor Nipaporn Sakulwongs, Ed.D.

Director of Master of Education Program in Curriculum and Instruction

Suryadhep Teachers College, Rangsit University

Muang-Ake, Paholyothin Road, Lakhok, Pathum Thani 12000 Thailand Telephone: Number: +66-868846226

Telephone: +662997-2222 ext. 1275

དཔལ་ལྡན་འབྲུག་གཞུང་། ཤེས་རིག་དང་རིག་རྩལ་གོང་འཕེལ་ལྡན་ཁག།

Royal Government of Bhutan
Ministry of Education and Skills Development
Department of School Education

ཤེས་རིག

DSE/SLCD (05)2024/ 508 April 24, 2024

Chief Dzongkhag/Thromde Education Officers
Paro and Wangdue Dzongkhags
Thimphu and Samdrupjongkhar Thromdes

Subject: Approval to collect data for research studies.

Dear Sirs/Madams,
The Director of the Master of Education Program in Curriculum and Instruction at Suryadhep Teachers College, Rangsit University in Thailand, has approached the Department of School Education seeking permission for the following five M.Ed candidates to collect data for their research study:

Candidates	Research title	Location
Tshering Dolkar	The use of Bar Model Method for addition and subtraction word problem achievement of grade 4 Bhutanese students	Dewathang Primary School, Samdrupjongkhar Thromde
Chimi Seldon Dorji	The effectiveness of experiential learning approach on science learning achievement for grade 6 Bhutanese students	Jigme Losel Primary School, Thimphu Thromde
Pema Choden	The effectiveness of virtual field trips on learning achievement of social studies for grade 6 Bhutanese students	Dechencholing Higher Secondary School, Thimphu Thromde
Kuenzang Namgay	The development of English reading comprehension skill using flipped classroom with poems among grade 6 Bhutanese students	Gaselo Primary School, Wangdue Dzongkhag
Chimi Selden	The effectiveness of using differentiated instructions on science learning achievement for grade 5 Bhutanese students	Taju Primary School, Paro Dzongkhag

The Department of School Education is pleased to accord approval to collect data as proposed, considering the positive impact of the research to elevate teaching methods at the primary level. However, the researchers are requested to avoid any disturbances to the normal instructional hours.

Hence, you are kindly requested to allow the researchers to conduct the data collection for their research project please.

(Karma Galay)
Director General

Cc: 1. Dasho Dzongdag/Thrompoen, Paro, Wangdue Dzongkhags and Thimphu, Samdrupjongkhar Thromde for kind information.
2. Director, Master of Education Program in Curriculum and Instruction, Suryadhep Teachers College, Rangsit University, Thailand for kind information
3. Chief Program Officer, School Liaison and Coordination Division, DSE for kind information

Date: 29/04/2024

PRINCIPAL'S CONSENT LETTER FORM

Respected sir,

I am currently pursuing my Master of Education in Curriculum and Instruction at Rangsit University, Thailand. I am conducting research on **"The Effectiveness of using Differentiated Instruction on Science Learning Achievement for Grade 5 Bhutanese Students".** The main purpose of this study is to determine the effectiveness of using Differentiated instruction in learning achievement of grade 5 Bhutanese in science subject and also to find out to what extent are students satisfied towards the use of differentiated instruction in science. I will be teaching on the topic Nutrition and Healthy habits from class V science instructional guide for a period of one month. During this period, a pre-test will be conducted before the lessons are being delivered and a post-test and an interview after the implementation of Differentiated Instruction.

Therefore, I would like to seek your prior consent to let grade five students take part in this research. I assure you that the information of the participants, such as their names, identities, and school will remain anonymous, and all the information will be kept confidential.

I look forward to your great support.

Thanking you.

Yours Sincerely,

Chimi Selden

M.Ed in C&I

I give my consent to conduct the research with grade five students of my school. I confirm and acknowledge that I am being made clear about the content of the research and have read the letter provided by the researcher.

Principal (Thinley Wangchuk)

Subject Teacher YESHEY LHAM

APPENDIX B

PARENT /GUARDAIN INFORMED CONSENT SAMPLE

PARENT/GUARDIAN INFORMED CONSENT LETTER

Dear parent/guardian,

I am currently pursuing Master of Education in Curriculum and Instruction at Rangsit University, Thailand. I am conducting research on **"The Effectiveness of using Differentiated Instruction on Science Learning Achievement for Grade 5 Bhutanese Students"** and I have chosen Taju Primary School as my research school.

To collect data for my research, I will be teaching Nutrition and Healthy habits from class V instructional guide for a period of one month. During this period, I will be conducting a pre-test, before implementing Differentiated Instruction in learning and post-test after teaching using Differentiated Instruction in learning. A semi-structured interview will be conducted at the end to investigate the students' learning satisfaction towards the use of Differentiated Instruction in learning science.

Since this research requires student participation, I would like to seek your permission to let your children participate in this study and as he or she is below 18 years. Therefore, I would like to request you to sign on their behalf. I assure you that your child's name, identity and information provided by them will remain confidential and anonymous at all times.

I look forward to your cooperation in approving your child's participation in this research.

Thanking you

Yours Sincerely

Chimi Selden

Researcher

For Parent/guardian use only

I acknowledge that I have read the letter and agreed to let my child ... Khesey Hang Subba. to participate in the above-mentioned research.

Name: Hemanta Kri Mongar Relation to child: Mother

Signature: Hemanta Date: 01/05/2024

APPENDIX C

EXPERTS WHO VALIDATED THE RESEARCH INSTRUMENTS

Experts Who Validated the Instruments

Sl.No	Name	Position title	Institution
1	Mr. Gary Torrenmucha	Professor (Teaching and Learning, Educational Technology)	Rangsit University English Language Institute
2	Mr. Bijoy Kumar Rai (Ph.D)	Assistant Professor (Teaching of Primary Science)	Paro College of Education, Royal University of Bhutan
3	Mr. Thinley Wangchuk	Assistant Professor (Science Education)	Paro College of Education, Royal University of Bhutan

Items validated:

1. Lesson plans
2. Learning Achievement Test
3. Semi-Structured Interview Questions

Consent Form for Disclosure of Validator's Name in the Research Paper

The Graduate School
Rangsit University
Thailand

I, Gary Torremucha, Professor, Rangsit English Language Institute (Rangsit University), hereby give my consent to the researcher Ms. Chimi Selden (6510233), pursuing her Masters in Curriculum and Instruction at the Suryadhep Teachers College (Rangsit University) to disclose my name as a research instrument validator in her thesis paper titled "The Effectiveness of using Differentiated Instruction on Science Learning Achievement for Grade 5 Bhutanese Students".

I respect the terms and regulations of the Graduate School and thereby I also give my consent to the Graduate School, Rangsit University to contact me in case of any clarifications sought regarding my consent.

Gary Torremucha

Signature
Date: 14 July 2024

Consent Form for Disclosure of Validator's Name in the Research Paper

The Graduate School
Rangsit University
Thailand

I, Bijoy Kumar Rai, Assistant Professor, Paro College of Education (Royal University of Bhutan), hereby give my consent to the researcher Ms. Chimi Selden (6510233), pursuing her Masters in Curriculum and Instruction at the Suryadhep Teachers College (Rangsit University) to disclose my name as a research instrument validator in her thesis paper titled "The Effectiveness of using Differentiated Instruction on Science Learning Achievement for Grade 5 Bhutanese Students".

I respect the terms and regulations of the Graduate School and thereby I also give my consent to the Graduate School, Rangsit University to contact me in case of any clarifications sought regarding my consent.

Bijoy Kumar Rai

Signature

Date: 25/04/2024

Consent Form for Disclosure of Validator's Name in the Research Paper

The Graduate School
Rangsit University
Thailand

I, Thinley Wangchuk, Assistant Professor, Paro College of Education (Royal University of Bhutan), hereby give my consent to the researcher Ms. Chimi Selden (6510233), pursuing her Masters in Curriculum and Instruction at the Suryadhep Teachers College (Rangsit University) to disclose my name as a research instrument validator in her thesis paper titled "The Effectiveness of using Differentiated Instruction on Science Learning Achievement for Grade 5 Bhutanese Students".
I respect the terms and regulations of the Graduate School and thereby I also give my consent to the Graduate School, Rangsit University to contact me in case of any clarifications sought regarding my consent.

Thinley Wangchuk

Signature
Date: 29 April 2024

APPENDIX D

SAMPLE LESSON PLANS

Lesson Plan 1 (Session 1 and 2)

Class:5 **Class Strength:** 30

Time:90 Minutes **Subject: Science**

Topic: Nutrition (Food Groups & Food Nutrients)

Teaching Strategy: Differentiated Instruction based on students' readiness

Teaching Learning Materials:

- ✓ Chart Paper with notes
- ✓ Worksheets (activity questions)
- ✓ Chart paper and marker pen
- ✓ Printed names of food groups and nutrients.
- ✓ Laptop and Projector
- ✓ Print out notes

Lesson Objectives: By the end of the lesson each child will be able to:

I. Explain the food nutrients and their functions for one's health.
II. Name at least three nutrients found in three different food groups.
III. Define macronutrients and micronutrients clearly with some examples.
IV. Sort out and classify food under different food groups and nutrients accordingly.

Lesson Components	Technique/activities	Time
Lesson Introduction	**Greeting** Teacher and students will exchange greetings. Then teacher will write the topic of the lesson the board and let students read it. **Topic introduction** The teacher will introduce the topic using pop-up technique where every student who raise their hand will be given a chance to think and share about their understanding on the topic. As they share their responses, teacher will use graphic organization to note on the board. After that, the teacher and students will read their responses together and teacher will	**10 mins**

<table>
<tr><th>Lesson Components</th><th>Technique/activities</th><th>Time</th></tr>
<tr><td></td><td>introduce the topic.</td><td></td></tr>
<tr><td>Lesson Development</td><td>Teacher will ask following questions:
▪ What did you eat in breakfast?
▪ What did you eat in dinner?
▪ Do you eat same type of food every day? Why?
After the discussion on the above questions with students, teacher will begin lesson.
General Lesson Input
✓ Teacher will talk and teach about the six basic nutrients and basic food groups.
Table 8.1 Primary Functions of the Six Major Nutrients
<table><tr><th>Nutrient</th><th>Primary functions</th></tr><tr><td>Water</td><td>Dissolves and carries nutrients, removes waste, and regulates body temperature</td></tr><tr><td>Protein</td><td>Builds new tissues, antibodies, enzymes, hormones, and other compounds</td></tr><tr><td>Carbohydrate</td><td>Provides energy</td></tr><tr><td>Fat</td><td>Provides long-term energy, insulation, and protection</td></tr><tr><td>Vitamins</td><td>Facilitate use of other nutrients; involved in regulating growth and manufacturing hormones</td></tr><tr><td>Minerals</td><td>Help build bones and teeth; aid in muscle function and nervous system activity</td></tr></table>Basic food groups:
1. Fruit and vegetables (Vitamins and Minerals).
2. Starchy food (Potatoes, bread, rice and pasta).
3. Dairy (Cheese, butter, yoghurts), (Protein & Vitamins).
4. Protein (Pulses (beans, peas, lentils), fish, eggs, meat).
5. Fat (oils).</td><td>25 mins</td></tr>
</table>

<table>
<tr><th>Lesson Components</th><th>Technique/activities</th><th>Time</th></tr>
<tr><td></td><td>✓ Teacher will teach about Macro and Micronutrients.
<table><tr><th>Macronutrients</th><th>Micronutrients</th></tr><tr><td>Macronutrients are required in large quantities.</td><td>Micronutrients are required in small quantities.</td></tr><tr><td>Also called as major elements.</td><td>Also called as trace elements.</td></tr><tr><td>Ex: Carbohydrates, protein and fats.</td><td>Ex: Vitamins and Minerals</td></tr></table>Additional Information
Teacher will play short videos on the topic food group, macro and micronutrients. Video links https://bit.ly/3pVecNV, https://bit.ly/3Hz2Vc8, and https://bit.ly/3BWr6Rt.</td><td></td></tr>
<tr><td>Lesson Activity 1</td><td>Activity based on students' readiness
Activity directions
✓ Teacher will divide class into three groups based on the pre-assessed information. (Note: Pre-assessment will be done one day before after consulting the subject teacher depending on Ss current level of readiness).
✓ Teacher will distribute worksheet and materials respectively to each group.
Students will read the questions, discuss among themselves and write answers in worksheet)</td><td>20 mins</td></tr>
</table>

<table>
<tr><th>Lesson Components</th><th>Technique/activities</th><th>Time</th></tr>
<tr><td></td><td>
Activity Questions
<table>
<tr><th>Below Average</th><th>Average</th><th>Above Average</th></tr>
<tr><td>Food Group Sorting</td><td>Nutrients and food group matching</td><td>Listing names, functions &examples of each nutrient</td></tr>
<tr><td>Q. a. From the provided materials sort out five food groups and label accordingly.
b. Select each food group and paste on the chart accordingly.
Note: Print out food and fruits pictures will be provided</td><td>Q a. Classify and categorize different foods and vegetables under six basic nutrients and label them accordingly.
b. Paste your matched nutrients and food group on the provided chart paper.
Note: Provide print out nutrients name cut-out along with different food group pictures.</td><td>Q. a. List names and function of each nutrient with example as indicated in the worksheet below.
Worksheet
<table>
<tr><th>Sl.no</th><th>Nutrients</th><th>Functions</th><th>Examples</th></tr>
<tr><td>1</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td></tr>
</table>
Note: Ss will discuss in the group and list in the provided work sheet.</td></tr>
</table>
</td><td></td></tr>
<tr><td>Follow-up of activity</td><td>✓ One student from each group will come in front and share their finding or work to the whole class.
✓ Other group members can ask questions if they are not clear with the idea presented.
✓ Teacher will supplement and provide feedbacks and corrections where ever there is a need.
Provide cheers to their group work.</td><td>10 mins</td></tr>
</table>

Lesson Components	Technique/activities	Time
Activity 2	**Whole Class Activity** **Activity directions** ✓ Teacher will provide worksheets which contain comprehension questions from the instructional guide. ✓ Teacher will read aloud each question. ✓ Students will write down their understanding. **Questions** 1. What is the function of carbohydrates and proteins? 2. Explain the importance of macro and micronutrients with examples. 3. What are the effects on your body, if you do not eat fruits and vegetables? 4. Why is water an important part of our diet? **Monitoring:** Teacher will monitor and provide help for anyone who needs help. **Follow up**: The teacher will check their answers and provide necessary feedback.	**15 mins**
Lesson Closure	Teacher will ask students to share their learning from the lesson. Students will be given chance to select and exhibit their learning as per their interest and choice from the following category: a) Verbal explanation b) Through drawing Written form	**10 mins**

Lesson Plan 4 (Session 7 and 8)

Class:5 **Class Strength:** 30

Time:90 Minutes **Subject:** Science

Topic: Healthy Habits (Junk food & BMI Calculation)

Teaching Strategy: Differentiated Instruction based on Learning Style

Teaching Learning Materials:

- ✓ Chart Paper with notes
- ✓ Worksheets (activity questions)
- ✓ Chart paper and marker pen
- ✓ Laptop and Projector
- ✓ Print out notes
- ✓ Bathroom scale and stadiometer

Lesson Objectives: By the end of the lesson each child will be able to:

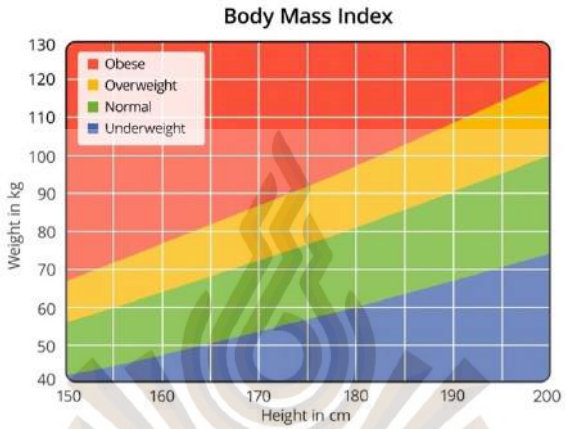
I. Define junk food and describe ways to limit eating junk food.

II. Calculate Body mass index (BMI) using appropriate formula.

III. Explain the significance of BMI to maintain good health.

Lesson Components	Technique/activities	Time
Lesson Introduction	**Greeting** Teacher and students will exchange greetings. The teacher will revise and recapitulate previous lesson, so that it helps them to connect to new lesson. Then teacher will write the topic of the lesson the board and let students read it. **Topic introduction** To introduce the lesson teacher will ask question as mentioned below: 1. Do your school have canteen? 2. What type of foods are available mostly? 3. Which food do you prefer to eat in the canteen? Why?	**10 mins**
	1. Do you bring pack lunch? After this discussion teacher will let students guess the topic for	

Lesson Components	Technique/activities	Time
	the day. Q. What do you think will be our topic for the day? Teacher will provide 2 minutes so that students think and brainstorm about the topic. After that, students will share their topic prediction. As each students share, teacher will note it on the chalkboard and make a list. Teacher and students will read the list, discuss and introduce the new topic.	
Lesson Development	**Round Table** ▪ Five students in group think and jot down their idea on the given question. ▪ Each student will take turn to jot down on the given worksheet. ▪ After the activity, students will be given the chance to share their answers to the whole class. Q. What do you understand by the term 'junk food'? **General Lesson Input** After the discussion on the above questions with students, teacher will provide feedback and supplement the idea further by talking about junk food, ways to control consuming junk food, concept of Body Mass Index (BMI) calculation and its significance as indicator of one's health. **Junk food**: Is a food that contains high levels of fats, salt or sugar, and lacks nutrients such as fiber, vitamins and minerals. Ex: Cakes, biscuits, and fast foods.	**30 mins**
Lesson Development	Ways to control eating junk food are; eat more cooked meal at home, eat more protein, get enough sleep, drink water and stop sweetened beverages, and consume snacks that are nutritious and low in calories. **Body Mass Index (BMI) calculation and its significance to the health** **Formula** BMI= $\frac{\text{Weight (Kg)}}{\text{Height}^2\text{(M)}}$	**30 mins**

Lesson Components	Technique/activities	Time
	Teacher will teach some examples to calculate BMI using the formula. **BMI range and interpretation**  ✓ Below 18 – Underweight ✓ 18.5- 24.9 – Healthy weight/ Normal ✓ 25.0-29.9 – Overweight ✓ 30.0 and above - obesity Significance of BMI ▪ It is an indicator of health. It helps to know the status of one's health and thus helps us to adopt healthy habits.	
Lesson Development	▪ Helps to determine any health risks that one may face if it's outside of the health range. ▪ The higher the BMI, the higher the risk for certain diseases such as heart disease, high blood pressure, diabetes, breathing problem and certain cancers. **Additional Information** Teacher will play short videos on BMI Calculation using the formula. Video link: https://bit.ly/3pU0M4H.	**30 mins**
Lesson Activity 1	**Activity based on Learning Style** **Activity directions** ✓ Teacher will instruct students to work in three groups	**25 mins**

<table>
<tr><th>Lesson Components</th><th>Technique/activities</th><th>Time</th></tr>
<tr><td></td><td>based on their learning style (Visual, auditory, and kinesthetic learner).
✓ The students will choose their preferences and go to the designated group table.
✓ The questions for each group will be different based on the learning style.
✓ Teacher will distribute, question, worksheet and materials respectively.
✓ Students will read the questions.
✓ Students will read and discuss among themselves.
✓ Teacher will assist if there is a need.
Students will compile their activity as per their group's question respectively.</td><td></td></tr>
<tr><td>Lesson Activity 1</td><td>Activity Questions
<table>
<tr><th>Auditory Learners</th><th>Visual Leaners</th><th>Kinesthetic Learners</th></tr>
<tr><td>Q. Engage in group discussions and create a speech or debates about the impact of junk food on health.</td><td>Q. Design visually appealing infographics (using chart paper, colours and label) illustrating the impact of consuming junk food.</td><td>Q. Measure Height (M) and Weight (Kg) among your group members. You should calculate BMI of each and interpret accordingly.</td></tr>
</table>
Monitoring: Teacher will monitor and provide help for any group who needs help while doing the activity.</td><td>25 mins</td></tr>
<tr><td>Follow-up of activity</td><td>✓ Teacher will let all three groups to present their work to whole class.
✓ The students will share/present their creation and</td><td>15 mins</td></tr>
</table>

Lesson Components	Technique/activities	Time
	findings to the whole class. ✓ Teacher will ask question, supplement and provide feedbacks and corrections where ever there is a need. ✓ Other group members can also ask question if they are not clear with the ideas presented. Provide cheers to appraise their work.	

APPENDIX E

IOC OF LESSON PLAN

IOC FOR LESSON PLAN BY THREE EXPERTS

Sl. No	Attributes	Expert 1	Expert 2	Expert 3	Average	Congruence
1	Lesson Plan 1	+1	+1	+1	+1	Congruent
2	Lesson Plan 2	+1	+1	+1	+1	Congruent
3	Lesson Plan 3	+1	+1	+1	+1	Congruent
4	Lesson Plan 4	+1	+1	+1	+1	Congruent

APPENDIX F

LEARNING ACHIEVEMENT TEST

LEARNING ACHIEVEMENT TEST

Student Code: …… Subject: Science Class: 5 Time: 45 Minutes

Total Marks: 20

Question1 Multiple Choice Questions (MCQ)

Direction: *Each question below is followed by four possible answers. Choose the most correct answer and write in the space provided. (5 Marks)*

I. What benefits are there in eating balanced diet?

A. Good health

B. Good mood and energy

C. Improved health and reduced illness

D. All of the above

……..

II. There are _____ basic nutrients

A. Six

B. Five

C. Seven

D. Eight

……

III.Fruits and vegetables fall under the category of _____

A. Protein

B. Fats

C. Vitamins and Minerals

D. Dairy

…….

IV. What are the drawbacks of using BMI to measure your health?

A. It is too general

B. It helps you to know your health status

C. It helps determine if you are at risk for disease

D. It can help you know if you should lose weight

……

V. All of following are the healthy habits, except _____

A. Drinking Water

B. Eating more vegetables

C. Reduce refined sugar

D. Eating leftover food

…….

Question 2 True or False

Direction: *State whether the following statements are true or false.* *(5 Marks)*

a. Healthy Weight or Normal BMI ranges from 18.5 to 24.9.

b. Soft drinks, sports drinks, sweet tea, lemonade and energy drinks are called as empty calorie food.

c. Energy giving food contains carbohydrates.

d. Potato, bread, rice and pasta falls under protein category.

e. Over nutrition is also a form of malnutrition.

Question 3 Fill in the blanks

Direction: *Fill in the blanks with the correct word that suits each statement.*

(5 Marks)

a. A _____contains an adequate amount of all the nutrients required by the body to grow, remain healthy and be disease- free.

b. BMI stands for _____

c. Cakes, biscuits, and fast foods are an example of _____

d. Bodybuilding food contains _____ .

e. Carbohydrates, protein and fats are called_____

Question 4 Short Answer Question

Direction: *Answer the following questions. Marks to each question are provided in brackets. (5 Marks).*

a. What are the effects on your body, if you do not eat fruits and vegetables? (1 mark)

……

……

……

……

b. Write down four benefits of eating balanced diet. (2 Marks)

……

……

……

……

c. How can you reduce eating junk food at your home? Mention four ways. (2 Marks)

……

……

……

……

Good Luck

BLUEPRINT FOR LEARNING ACHIEVEMENT TEST

Content	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Total
Multiple choice questions (MCQ)	Q 1(ii)	Q1(i)		Q 1(iii &iv)	Q1(v)		5
True/ False	Q2a,	Q2d		Q2e	Q2b, c		5
Fill in the blanks	Q3b,	Q3a, d	Q3e	Q3c			5
Short answer questions			Q4c	Q4a		Q4b	5
Total	3	4	3	5	3	2	20

APPENDIX G

IOC FOR LEARNING ACHIEVEMENT TEST

IOC FOR LEARNING ACHIEVEMENT TEST QUESTIONS BY THREE EXPERTS

Questions	Items	Expert 1	Expert 2	Expert 3	Average	Congruence
Question 1 MCQ	I	+1	+1	+1	+1	Congruent
	II	+1	+1	+1	+1	Congruent
	III	+1	+1	+1	+1	Congruent
	IV	+1	0	+1	0.67	Congruent
	V	+1	0	+1	0.67	Congruent
Question 2 True/False	a	+1	0	+1	0.67	Congruent
	b	+1	+1	+1	+1	Congruent
	c	+1	+1	+1	+1	Congruent
	d	+1	+1	+1	+1	Congruent
	e	+1	+1	+1	+1	Congruent
Question 3 Fill in the blanks	a	+1	+1	+1	+1	Congruent
	b	+1	+1	+1	+1	Congruent
	c	+1	+1	+1	+1	Congruent
	d	+1	+1	+1	+1	Congruent
	e	+1	+1	+1	+1	Congruent
Question 4 Short answer question	a	+1	+1	+1	+1	Congruent
	b	+1	+1	+1	+1	Congruent
	c	+1	0	+1	0.67	Congruent

APPENDIX H

SEMI-STRUCTURED INTERVIEW QUESTIONS

SEMI-STRUCTURED INTERVIEW QUESTIONS

Sl. No	Semi-structured Interview Questions
	PART I: INTEREST AND MOTIVATION
1	Did you enjoy the science lessons? Why?
2	Have you ever experienced a learning approach like this in the past? When and why?
3	What are your feelings about learning science through this differentiated instruction approach?
	PART II: EFFICACY OF DIFFERENTIATED INSTRUCTION ON STUDENT'S LEARNING
4	What did you enjoy the most while participating in the classroom activities?
5	Do you think the use of Differentiated Instruction approach helped you to learn science better? Why or why not?
6	Would you prefer to learn other subjects through the differentiated instruction approach? Why?

Adapted from Pem, 2022

APPENDIX I

IOC FOR SEMI-STRUCTURED INTERVIEW QUESTIONS

IOC FOR SEMI-STRUCTURED INTERVIEW QUESTIONS

Sl. No	Items	Expert 1	Expert 2	Expert 3	Average	Congruence
PART I: INTEREST AND MOTIVATION						
1	Did you enjoy the science lessons? Why?	+1	+1	+1	+1	Congruent
2	Have you ever experienced a learning approach like this in the past? When and why?	+1	+1	+1	+1	Congruent
3	What are your feelings about learning science through this differentiated instruction approach?	+1	+1	+1	+1	Congruent
PART II: EFFICACY OF DIFFERENTIATED INSTRUCTION ON STUDENT'S LEARNING						
4	What did you enjoy the most while participating in the classroom activities?	+1	+1	+1	+1	Congruent
5	Do you think the use of Differentiated Instruction approach helped you to learn science better? Why or why not?	+1	+1	+1	+1	Congruent
6	Would you prefer to learn other subjects through the differentiated instruction approach? Why?	+1	+1	+1	+1	Congruent

APPENDIX J

RELIABILITY TEST SCORES OF LEARNING ACHIEVEMENT TEST

RELIABILITY TEST SCORES OF LEARNING ACHIEVEMENT TEST

STUDENTS ID		TEST ITEMS/QUESTIONS																	TOTAL SCORE
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	
1	Std 1	0	1	1	0	1	1	1	1	0	0	1	1	1	0	0	0	0	1	10
2	Std 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	17
3	Std 3	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	0	1	1	14
4	Std 4	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	16
5	Std 5	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	16
6	Std 6	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	1	12
7	Std 7	0	1	1	0	1	1	1	1	0	1	1	1	0	0	1	1	1	1	13
8	Std 8	1	1	1	0	1	1	1	0	1	1	1	0	0	0	0	0	1	1	11
9	Std 9	1	1	1	1	1	1	0	1	0	0	1	1	0	1	1	0	1	1	13
10	Std 10	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	0	1	1	15
11	Std 11	1	1	1	1	1	1	1	0	1	1	0	1	0	0	0	0	1	1	12
12	Std 12	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	5
13	Std 13	1	1	1	1	1	1	0	1	1	0	1	1	0	0	1	0	1	1	13
14	Std 14	1	1	1	1	1	1	1	0	1	0	1	1	0	0	0	0	1	0	11
15	Std 15	1	1	0	1	1	1	1	0	1	0	1	1	0	1	0	0	1	1	12
16	Std 16	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0	1	1	13
17	Std 17	0	1	0	0	1	1	1	0	0	0	1	0	1	0	0	0	1	1	8
18	Std 18	1	1	0	0	1	0	1	1	1	1	1	1	0	0	0	1	1	1	12
19	Std 19	0	1	1	0	1	1	1	0	0	0	0	1	0	1	0	0	1	1	9
20	Std 20	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	15
21	Std 21	1	1	1	0	1	0	0	1	1	1	1	1	0	1	0	0	1	1	12
22	Std 22	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	1	1	8
23	Std 23	1	1	1	1	1	0	0	1	1	1	1	1	0	1	0	0	1	1	13
24	Std 24	1	1	1	1	1	0	0	1	1	1	1	1	0	1	0	0	1	1	13
25	Std 25	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	12
26	Std 26	0	1	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	6
27	Std 27	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	5
28	Std 28	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	1	8
29	Std 29	0	1	1	0	0	1	1	0	0	0	0	1	0	0	0	0	1	1	7
30	Std 30	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0	0	0	11
31	Std 31	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	16
32	Std 32	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	17
33	Std 33	1	1	0	0	1	0	1	1	1	1	1	1	0	0	0	0	1	1	11
34	Std 34	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	0	1	1	14
Total correct response		24	30	25	16	32	26	26	23	24	21	27	27	5	17	12	3	30	32	10.36
	p	0.71	0.88	0.74	0.47	0.94	0.76	0.76	0.68	0.71	0.62	0.79	0.79	0.15	0.50	0.35	0.09	0.88	0.94	
	q	0.29	0.12	0.26	0.53	0.06	0.24	0.24	0.32	0.29	0.38	0.21	0.21	0.85	0.50	0.65	0.91	0.12	0.06	
	Σpq	0.21	0.10	0.19	0.25	0.06	0.18	0.18	0.22	0.21	0.24	0.16	0.16	0.13	0.25	0.23	0.08	0.10	0.06	2.535

SOLUTION METHOD A	
K	18
Σpq	2.54
Var (σ2)	10.36
KR 20	0.800

APPENDIX K

PAIRED SAMPLE T-TEST

Paired Sample T-Test

Paired Sample Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test	8.58	30	2.499	.456
	Post-test	14.37	30	2.883	.526

Paired Sample Correlations

	N	Correlation	Sig
Pair 1 Pretest & Posttest	30	.558	.001

Paired Sample Test

	Paired Differences					t	df	Sig (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pretest-Posttest	-5.783	2.552	.466	-6.736	-4.830	-12.413	29	.000

APPENDIX L
GLIMPSES OF DIFFERENTIATED INSTRUCTION CLASSROOM

Picture Courtesy: Researcher

BIOGRAPHY

Name	Chimi Selden
Date of birth	June 27, 1994
Place of birth	Monggar, Bhutan
Education background	Paro College of Education, Royal University, Bhutan Bachelor of Education, 2018 Rangsit University, Thailand Master of Education in Curriculum and Instruction, 2024
Scholarship	Trongsa Penlop Scholarship (TPS)
Email Address	cselden2019@education.gov.bt
Address	Monggar, Bhutan
Place of work	Tsakaling PS, Ministry of Education and Skills Development, Bhutan
Work position	Teacher III Position level: P5 A