Research Article

THE IMPACT OF INDUCTIVE TEACHING STRATEGY WITH GEOGEBRA ON MATHEMATICS LEARNING ACHIEVEMENT AND ENGAGEMENT IN GRADE FIVE BHUTANESE STUDENTS

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ABSTRACT

This study employed a mixed method to gather the required data to examine the impact of an Inductive Teaching Strategy with GeoGebra on the grade five Bhutanese students' learning achievement and engagement in mathematics. The sample of the study consisted of 30 grade five students from one of the semi-urban school of Bhutan. The study employed achievement tests (pre-test and post-test) and semi-structured interview as instruments for collecting data and classroom observation as additional evidence to strengthen the results from the achievement test and semi-structured interview. The instruments were validated by three experts and tested for reliability using Kuder Richardson-20 (KR-20) formula having a value of 0.78. The quantitative data were analyzed using a paired sample t-test using statistical software. The result revealed a higher mean score in the post-test (12.78) than that of the pre-test (7.03) with the mean difference of (5.75). The significant (p) value 0.01 indicated that the use of Inductive Teaching Strategy with GeoGebra was effective in teaching and learning mathematics. Qualitative data were analyzed using the thematic analysis technique. The result revealed that integrating the Inductive Teaching Strategy with GeoGebra remarkably enhanced students' engagement

in mathematics. The findings showed that the use of Inductive Teaching Strategy with GeoGebra has a potential to foster improved understanding and enhance students' engagement in teaching mathematics in grade five Bhutanese students.

Keywords: Inductive Teaching Strategy, GeoGebra, Learning Achievement, Engagement, Mathematics

INTRODUCTION

In Bhutan, the educational landscape has been rapidly growing to integrate digital learning tools to enhance student learning and engagement. Paul (2017) states that traditionally, Bhutanese education primarily focused on monastic education, emphasizing the growth of Buddhist studies and spiritual learning. However, in the 1960s, under the guidance of the third king, Jigme Dorji Wangchuk, the country began establishing its first secular schools, shifting toward a more formal education system that emphasized both traditional values and modern subjects. As the years rolled on, Bhutan expanded access to education, aiming to provide free schooling for all Bhutanese children. Sherab (2013) states that the development of the curriculum focused on the inclusion of secular subjects like science, mathematics, and social studies while still preserving the Bhutanese language and cultural values. Thus, Bhutan became one of the youngest countries in modern education in the 60s, when modern education was first introduced in the country. Since then, mathematics is considered as a core subjects in Bhutan, forming the foundation for higher studies in science, engineering, technology, and economics. Strong mathematical skills are essential for students' academic achievent and career opportunities.

The importance of mathematics is often regarded as the "language of the universe,' while it provides a foundational framework for understanding and describing natural phenomena. The application of mathematics is vast and everywhere, starting from the structure of atoms until the formations of galaxies. Through the global advancement of science, technology, and philosophy, mathematics contributed to the advancement of civilization. For instance, to execute counting as a mathematical idea, early humans employed notched bones, tree incisions, and lines on the ground. Following this, more sophisticated mathematical

activities have been observed in people throughout mathematics history (Denbel, 2023). One of the main aspects of mathematics is that it fosters critical thinking and problem-solving skills, unlike other subjects. According to the National Research Council (2001), engaging in mathematical reasoning can help students develop logical thinking, which is essential for tackling complex real-world problems. The concepts of mathematics begin with our day-to-day life chores, from cooking and traveling to budgeting and managing time. Mathematics problems should encourage and acknowledge the different ways in which people see mathematics and the various approaches they take to problem-solving, and when these changes happen, students become more proficient and extremely engaged in arithmetic (Boaler, 2022).

Despite mathematics being significantly important in our daily life and being one of the major subjects in schools, it is believed that students perform poorly in the subject. As per the Organization for Economic Co-operation and Development (OECD, 2023), the report from the Programme for International Student Assessment (PISA, 2022) shows that between 2018 and 2022, the mean performance in mathematics across OECD countries fell by a record of 15 points. Similarly, the National Assessment of Educational Progress (NAEP, 2022) of the United States shows that only 26% of 8th grade students have met the proficiency level in mathematics, which is a clear drop from the previous year. Similarly, Bhutan also considers mathematics as a low-performing subject compared to the other subjects. The School Curriculum Division (2023) states that students in the Bhutanese context will be continuously challenged to solve problems, use logical reasoning, draw connections, and represent concepts in a variety of ways.

Additionally, the Curriculum and Professional Support Division (CAPSD, 1996) states that many Bhutanese students have found learning mathematics to be a nightmare, which has caused them to lose interest in the subject. Most of the students of Bhutan have shown poor performance in mathematics. Around 30% of students in Bhutan have failed mathematics exams in recent years, a trend that educational experts link to various factors, including teacher preparation, an outdated curriculum, teaching strategy, and student apprehension towards the subject

(The Bhutanese, 2025). The curriculum framework by the School Curriculum Division, Bhutan (2023) states that the majority of Bhutanese students scored below 50% since mathematics is one of their primary areas of weakness and they dislike learning it. Bhutan Council for School Examinations and Assessment (BCSEA, 2019) reported that the average score for grade VI mathematics for the academic year 2018 was low compared to the other subjects.

To address those continued issues with student motivation, comprehension, and performance, there has been a clear motivation in mathematics education toward creative teaching approaches. Rigzin (2021) states that one of the core factors affecting poor performance in mathematics is the inappropriate use of teaching strategies. The lack of interactive, hands-on activities makes mathematics feel disconnected from students' everyday experiences. Teaching methods that rely heavily on teacher-centered methods fail to stimulate curiosity and motivation, leaving students bored about the subjects. Lham (2017) states that the moment has come to realize that teaching in the twenty-first century involves more than just imparting knowledge. As a result, incorporating strategies like group work, discussions, and hands-on activities encourages students to participate actively in learning. Bhutan's education system has recognized the importance of adapting to new methodologies to increase student engagement and improve learning outcomes (Ministry of Education [MoE], 2019).

To make mathematics more approachable and interesting for young students, Inductive Teaching Strategy with GeoGebra can be used as it is more student-centered than traditional deductive strategy. According to Misrom et al. (2020), the Inductive Teaching Strategy is one such instructional strategy that has been investigated and has produced excellent results in the teaching and learning of mathematics by fostering higher order thinking skills. Similarly, Singh (n.d) states that the Inductive Teaching Strategy has many advantages that improve conceptual understanding, critical thinking, and student engagement. This method promotes active learning and makes lessons more participatory and engaging by encouraging students' to observe specific examples and draw general principles. Bordia (2021) states that as the Inductive

Teaching Strategy is student-centred, it places more emphasis on an interactive learning environment where students take charge of their education rather than teacher teaching.

On the other hand, initiatives to integrate technology into the classroom have accelerated after the pandemic era. The Ministry of Information and Communication (MoIC, 2004) states that ICT is essential to school education, both in terms of the students' future and in terms of offering resources to enhance teaching and learning. According to Higgins et al. (2017), students' behaviors, such as being inspired to approach learning proactively, emotions in terms of their motivation and engagement, and mental engagement like cognitive investment required to comprehend content are all impacted by the use of technology in the classroom. Simons and Edward (2019) state that the majority of teachers use computers for Google Classroom or PowerPoint presentations, but this is not the same as using a computer as an interactive tool to directly teach and explore a mathematical subject. In this effort, one of the most useful tools is GeoGebra, which is a widely used digital platform for teaching mathematics. Geogebra is a dynamic mathematics software that was developed by Markus Hohenwarter in 2001.

GeoGebra, which was first created for higher-level mathematics, has been useful at many educational levels, including primary education (Hohenwarter & Lavicza, 2007). According to Dabbagh and Kitsantas (2012), GeoGebra is a useful tool for encouraging deeper understanding and mathematical engagement in students through interactive learning experiences. GeoGebra advances Bhutan's goal of incorporating technology into the classroom, tackling current learning difficulties in subjects like mathematics while preparing students for a digital future. GeoGebra is easy to use, and it can improve mathematical visualization and comprehension.

Therefore, integration of Inductive Teaching Strategy with GeoGebra has a greater impact on students' mathematical learning achievement and engagement. According to Benning (2021), Inductive Teaching Strategies helps students identify patterns, generate hypotheses, and arrive at general principles through investigation and reasoning. This strategy is supported by the dynamic mathematics software

GeoGebra, which promotes deep understanding and discovery learning by enabling dynamic manipulation of mathematics objects. Furthermore, one of the components of Inductive Teaching Strategies is collaborative exploration, where students can share their observations and generate group insights. The features of GeoGebra support this by enabling students to collaborate on dynamic constructions which promotes collaborative learning. Mathematical critical thinking and problem-solving skills have been demonstrated to improve in such collaborative environments (Schaver, 2019).

However, little is known about how Inductive Teaching Strategy with GeoGebra affects mathematics learning achievement and student engagement in the Bhutanese environment. According to Dolma (2016), few studies have been conducted on the effectiveness of the education system in general and mathematics instruction in particular in Bhutan's history of modernizing its educational system. For example, Dukpa (2015) had conducted a study to ascertain the attitude of Bhutanese students towards mathematics learning and a case study was conducted by Utha et al. (2016) on the quality of school education in Bhutan. Therefore, the purpose of this study was to investigate the impact of Inductive Teaching Strategy with GeoGebra on the learning achievements and engagement of grade five Bhutanese students as they are accessible population for the researcher where researcher can directly reach to them. This research informed teachers and policymakers about the benefits of incorporating Inductive Teaching Strategy with technologies, contributing to a more engaging and supportive learning environment for students. Furthermore, this study aimed to highlight the transformative potential of Inductive Teaching Strategy with technology in primary education after analyzing the students' learning achievement and engagement level before and after using Inductive Teaching Strategy with GeoGebra. This study not only addressed existing gaps in academic literature regarding the use of Inductive Teaching Strategy with digital learning tools in Bhutan but also set the stage for future research on teaching strategy with digital learning tools in enhancing educational achievements.

RESEARCH OBJECTIVES

1) To assess how the Inductive Teaching Strategy with GeoGebra can enhance grade five bhutanese students' learning achievement in mathematics.

2) To evaluate the impact of using Inductive Teaching Strategy with GeoGebra on grade five Bhutanese students' engagement in mathematics.

EXPECTED BENEFITS

The researcher expected:

1) The use of Inductive Teaching Strategy with GeoGebra will exhibit better learning achievements in mathematics in grade five Bhutanese students.

2) The study's conclusions give mathematics teachers another option for using Inductive Teaching Strategy with GeoGebra as one of the creative teaching methods.

RESEARCH SCOPE

The scope of this study consisted of the following:

Location of the Study

This study was conducted in one of the primary schools under Phuentsholing sub-district in southern part of Bhutan. The school is semi-urban and it is a public school with 108 students and 8 teachers.

Population and Sample

This study engaged 30 grade five students from one of the primary schools under Phuentsholing sub-district in Bhutan since the school consisted of only one section of grade five. Students were of mixed abilities in mathematics and gender. The age of the students ranged from 11 to 13 years. They are accessible population for the researcher where researcher can directly reach to them. To put it simply, these students were regarded as the participants of the study.

Time Frame

The researcher conducted this study for four weeks by teaching one lesson each week. Each lesson consisted of 90 minutes while taking two periods of 45 minutes in one week to cover a lesson. The study was carried out from May to June during the first term of the academic year 2025. In total, the researcher taught eight periods in four weeks using Inductive Teaching Strategy with GeoGebra software in Mathematics.

LITERATURE REVIEW

Inductive Teaching Strategy

According to Eggen and Kauchak (2016), the Inductive Teaching Strategy is the approach whereby it progresses

from specific to general since students are first given data, examples, or particular cases from which they draw conclusions about patterns and eventually formulate general rules or principles. This strategy allow students to observe patterns, gather information and formulate generalizations or principles on their own rather than giving students direct instruction or rules at the beginning. One of the main ideas is student-centered learning, which encourages students to actively participate in their own education by observing, exploring, and drawing conclusions rather than just passively absorbing knowledge.

Another important idea is the encouragement of inquiry and exploration, which inspires students to test theories, pose questions, and look for different answers. The teacher in this context is not so much a source of knowledge as a facilitator or guide (Hmelo-Silver, Duncan, & Chinn, 2007). For students to benefit from this method, the idea of scaffolding and support is crucial. Initially, teachers offer guidance in the form of leading questions, structured examples, and appropriate tools. As students develop confidence and independence, teachers gradually withdraw their support, a process known as the gradual release of responsibility (Fisher & Frey, 2014). Constructivist learning theory, which holds that students actively create their own understanding based on their past knowledge and interactions with the learning environment, serves as the foundation for all of these components (Schunk, 2016). The importance of inductive teaching in creating rich, meaningful learning experiences is supported by this theoretical foundation.

Application of Inductive Teaching Strategy in Mathematics

According to Atta et al. (2015), Inductive Teaching Strategy proceeds from particular examples to general rules of formulae, concrete illustration to abstract rules, known to unknown and simple to complex. He states that following steps are used to implement Inductive Teaching Strategy:

1. Appearance of presentation of examples
2. Observation or reflection
3. Generalization
4. Testing and verification

These steps help students to logically acquire knowledge of the Inductive Teaching Strategy. This is supported by experiential learning theory as it is considered as an ongoing cycle in which students participate in an activity, think critically

about it, gain conceptual understanding, and then use that understanding in practical settings (Kolb, 1984).

GeoGebra as an Educational Tool

Ngyenwa (2015) defines that GeoGebra is a dynamic, free computer program that integrates algebra and geometry into an intuitive, mouse-driven package. Students might be able to explore and experiment with specific mathematical ideas using this software instead of needing the teacher to spoon-feed them. Developed by Markus Hohenwarter in 2001, GeoGebra software helps students acquire lots of mathematical skills like problem-solving, reasoning, critical thinking, and creative thinking. It also keeps students engaged and motivated throughout the course. Because of its versatility, it can be used to draw shapes, take measurements, and use coordinates and equations, all essential for thoroughly investigating geometric concepts. GeoGebra improves overall mathematical fluency by giving students a platform to actively experiment with mathematical concepts.

GeoGebra is a vital tool in the ever-changing field of teaching and learning mathematics because of its special features, which include motion tracking and thoughtful design for meaningful math learning (Gurmu, Tuge, & Hunde, 2024). This software can be used by teachers to deliver the content to students as well as by the students to explore the mathematical activities and concepts. When a teacher uses this software to present the Mathematical contents to the students, it can create a visual representation of those contents, and when students use the software, it increases student engagement and helps them develop their digital competencies.

Application of GeoGebra in the Classroom

The application of GeoGebra to teach the area measurement of a rectangle can make the concept more interactive and visually engaging for students. Here is how mathematics teachers can incorporate GeoGebra into your lesson in three stages:

1. Preparation Stage: The Teacher can use GeoGebra to prepare interactive resources to teach the area of rectangles effectively before the lesson.

2. Engagement Stage: During the lesson, teachers can project the GeoGebra to facilitate interactive learning.

3. Reflection and Extension Stage: For further exploration and reflection, teachers can share GeoGebra with the students through GeoGebra Classroom or Google Classroom.

According to a study by Yildiz and Kirickcilar (2018), GeoGebra, a dynamic mathematics program, serves as an effective tool within the Technological Pedagogical Content Knowledge (TPACK) framework through the integration of technology into Inductive Teaching Strategy in mathematics education. TPACK, which assists teachers in effectively incorporating technology into their lesson plans, emphasizes the intersection of technological, pedagogical, and content knowledge.

Benefits of integrating Inductive Teaching Strategy with GeoGebra

The integration of Inductive Teaching Strategy with GeoGebra into Class Five Mathematics instruction will offer some benefits for both teachers and students. This is supported by most of the research studies that were carried out recently. Therefore, here are some of the key advantages that are supported by the relevant studies:

1. Promotes interactive learning
2. Enhance visual representations
3. Enhance engagement
4. Immediate feedback
5. Supports differentiated instruction
6. Encourage inquiry-based learning
7. Prepares students for advanced learning

HYPOTHESIS

1) Grade five Bhutanese Students' learning achievement in mathematics would significantly be improved after the use of Inductive Teaching Strategy with GeoGebra.

2) Grade five Bhutanese students would exhibit a remarkable engagement in learning mathematics using Inductive Teaching Strategy with GeoGebra.

CONCEPTUAL FRAMEWORK OF THE STUDY

This study investigated the relationship between the independent variable, the use of the Inductive Teaching Strategy with Geogebra, and the dependent variables, namely students' learning achievement and engagement. The Inductive Teaching Strategy with GeoGebra served as the intervention expected to influence and enhance both learning achievement which is tested by the pre-test and post-test and engagement among students which is investigated by semi-structured interview. The framework is illustrated below:

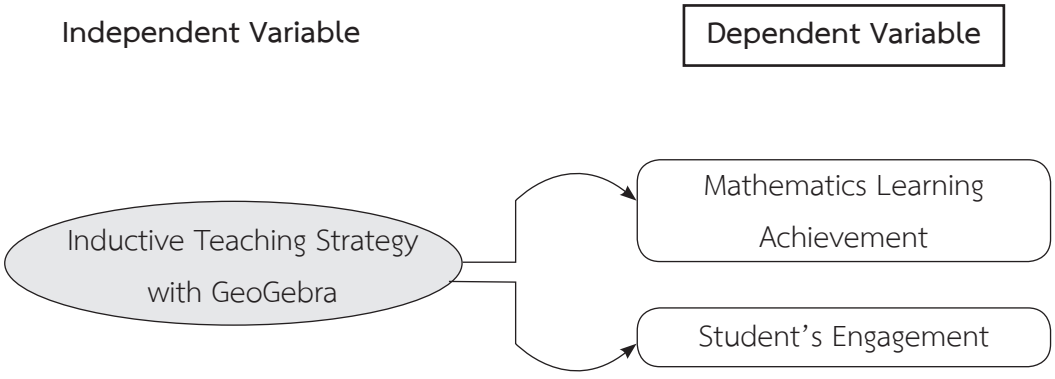

Figure 1 Illustration of the Independent Variable and Dependent Variable

RESEARCH METHODOLOGY

This study adopted a mixed methodology as McKim (2017) states that the overall validity is increased by the improved and broader understanding that mixed methods offer, and it also enhances accuracy and confidence. Additionally, Almaki (2016) states that to gather comprehensive data, researchers uses a mixed method, which combines elements of both qualitative and quantitative research approaches.

RESEARCH INSTRUMENTS

The study was conducted with the aim of determining the impact of Inductive Teaching Strategy with GeoGebra on mathematics learning achievement and engagement in grade five Bhutanese students. In this study, researcher included four different instruments to collect data. Four lesson plans to teach the lessons, learning achievement test to collect quantitative data, semi-structured interview to collect qualitative data and classroom observation to provide additional evidence to strengthen the results from the achievement test and semi-structured interview.

Quantitative Data Collection Instruments

Lesson Plans

In this study, the researcher prepared four lesson plans of 90 minutes each to teach grade five research participants about 'Area and Perimeter' from the mathematics subject. The four lesson plans were validated by three experts (refer table 1 for the IOC result). The lessons were taught over four weeks with two sessions each week

consisting of 45 minutes each. The lessons were designed by incorporating an inductive Teaching Strategy with GeoGebra in lesson activities. Throughout the sessions, participants participated and learned the lesson through Inductive Teaching Strategy with GeoGebra.

Learning Achievement Test

A teacher developed a test, which was conducted before and after the intervention to measure students' learning achievement in the target topics (area and perimeter of a rectangle). The test consisted of a pre-test, which was conducted before the intervention, and a post-test, which was conducted after the intervention. The test was conducted for the same group of students using the same questions. Test questions were developed based on Bloom's Taxonomy and as per the guidelines of the REC curriculum framework of Bhutan and BCSEA guidelines. It included 5 marks multiple choice questions, 5 marks true or false questions, and 10 marks short answer type questions. The learning achievement test questions were validated by three experts and indicated that the learning achievement test questions were valid and accurate (refer table 1 for the IOC result).

Qualitative Data Collection Instrument

Semi-Structured Interview

A semi-structured interview was used as a qualitative research instrument to measure students' engagement in mathematics learning when using Inductive Teaching Strategy with GeoGebra. This method was chosen because it allowed for a flexible and guided exploration of students' experiences. According to Adams (2015), in semi-structured interviews, the interviewee is free to share their opinions and points of view. The semi-structured interview questions were validated by three experts (refer table 1 for the IOC result). During the interview, six questions were asked in a homogenous group of four students each. Students were given the freedom to speak in the language of their choice (English or Dzongkha, the national language of Bhutan). Each interview lasted around 10-15 minutes and was audio-recorded (with permission) to ensure accurate data collection. Each group's responses were recorded in audio during the interview and later translated and transcribed into English.

Classroom Observation

Classroom Observation was conducted during the lessons to assess students' learning achievement and engagement. It provided additional evidence to strengthen the results from the achievement test and semi-structured interview, making the study more credible. According to Satapathy (2019), the researchers uses observation as a data collection tool to gather real-time data using his or her sense of observation in controlled or naturalistic event occurrence scenarios. In this study, the researcher asked help from one of the mathematics teachers from the target school to observe the lesson. The teacher was provided with the observation checklist prepared by the researcher.

Validity

Validity is the instrument's capacity to measure, and content validity is the relationship and connection between the test items and the related subject matter (Mushtaq, 2018). So, in this study, the research instruments were reviewed by three experts: a professor from Rangsit University, Thailand, and two experienced mathematics teachers from Bhutan and ensured alignment with the curriculum and learning objectives. The validity of the instrument was measured through the Item Objective Congruence Index (IOC), a method used to assess how well an instrument aligned with the desired learning objectives. If an item had a score of 0.67 and above, it was considered valid, whereas the items with IOC scores below 0.67 was considered to be revised or removed as per the feedback from experts. All the instruments for this study were validated and rated with the score of +1 by the validators, which indicated that all the items were congruent and valid for the study.

Table 1 IOC for Research Instruments

Instruments	Expert 1	Expert 3	Expert 3	Average
Lesson Plans	+1	+1	+1	+1
Achievement Test	+1	+1	+1	+1
Semi-Structured Interview	+1	+1	+1	+1
Classroom Observation	+1	+1	+1	+1

Reliability

According to Karnia (2024), reliability is the process of measuring variables so that they can produce consistent measurement and results under repeated circumstances. In this study, Kuder-richardson formula (KR-20) from statistical Package for Social Science (SPSS) software was used to check the reliability coefficient of the learning outcome of the test. The reliability of the achievement test was administered to the 28 students of grade six in the same school on 6th may, 2025. Test questions consisted of 5 marks multiple choice questions, 5 marks true or false questions, and 10 marks short answer questions. The KR-20 coefficient obtained must be at least 0.70 to make the test items reliable. In this study, the KR-20 Coefficient obtained was 0.78 and it indicated that all the items were congruent and valid for the study.

DATA COLLECTION METHODS

Approval and Ethical Consideration

Written consent was obtained from the Research and Development Institute, Rangsit University, Ministry of Education and Skills Development of Bhutan, Chhukha Dzongkhag Administration, School Administration (Research School), concerned subject teachers, parents, and students before the study began.

Participant's Consent Approval

Since the participants were below the legal age, the parents of every research participant were informed and aware of the content of the consent letter before they signed to minimize the violation of rights of the research participants during the study. Research participants were assured that their information would be kept confidential and that it would not affect their course grades.

Data Analysis

Quantitative Data Analysis (Learning Achievement Tests)

Before and after the intervention, 30 Bhutanese students in Grade five took the 14 questions in pre-test and post-test. To determine the impact of using Inductive Teaching Strategy with Geogebra in a Bhutanese classroom, pre-test and post-test scores were compared using a paired sample t-test. The comparisons were made based on the significance value (P-Value), mean, and standard deviation. The comparisons were also carried out "within the group" by comparing the sample group's pre-test and post-test scores.

Qualitative Data Analysis (Semi-Structured Interview)

At the end of the study, the researcher conducted a semi-structured interview in a homogenous group of 4 participants. The groups were formed considering their post-test scores. Each group had a mixed of high scorer, low scorer, and intermediate scorer students. The responses of the students were recorded and transcribed in English. The collected data were read, analyzed, and coded into themes aligned with the research objectives and research questions (refer Appendix A).

Analysis of Classroom Observation

During the lesson delivery, the researcher requested a school mathematics teacher to observe the lesson. The observations main objective was to supplement and support the result from achievement test and semi-structured interview. Classroom observation was done using checklist to record the observation by observer and later, it was coded into themes aligned with the research objectives and research questions (refer Appendix B).

RESULTS CONCLUSIONS AND DISCUSSION

Result of Learning Achievement Tests

The first objective was to assess how the Inductive Teaching Strategy with GeoGebra can enhance grade five Bhutanese students' learning achievement in mathematics. Table 2 below showed the comparisons of the sample group's pre-test and post-test results. The pre-test and post-test scores were analyzed to compare the learning achievement of grade five Bhutanese students before and after the intervention. It showed the results of the descriptive statistical analysis for the achievement test scores

of the sample group. As shown in the table 2 below, the mean score for pre-test was 7.03 and the mean score for post-test was 12.78. The result shown in the table clearly showed that the group's post-test mean score ($\overline{X}$ = 12.78) was higher than its pre-test mean score ($\overline{X}$ = 7.03), with a mean difference of 5.75. The impact of Inductive Teaching Strategy with Geogebra was demonstrated by the higher mean score on the post-test. Additionally, a paired sample t-test in the table showed a significant (p) value of 0.01, indicating the test's significance as it is lower than 0.05. If p 0.05, the difference is considered statistically significant. The standard deviations for the pre-test and post-test were 2.91 and 2.15 as shown in table 2 below.

Thus, the study came to the conclusion that there was a significant improvement in learning achievement of grade five Bhutanese students when Inductive teaching Strategy with GeoGebra was used to teach mathematics. Accordingly, the first research hypothesis "Grade five Bhutanese Students' learning achievement in mathematics will significantly be improved after the use of Inductive Teaching Strategy with GeoGebra" was proven to be correct.

Result of Semi-Structured Interview

The second objective was to evaluate the impact of using Inductive Teaching Strategy with geoGebra on grade five bhutanese students' engagement in mathematics. The data collected from semi-structured interviews

Table 2 The comparison of the sample group's pre-test and post-test

Group	Pre-test		Post-test		Mean Difference	T	P-Value
	$\overline{X}$	SD	$\overline{X}$	SD			
Sample Group	7.03	2.91	12.78	2.15	12.78-7.03 = 5.75	- 11.425	0.01
Significance level (P): <0.05 - Significant							

were analyzed under three themes: 1) Active participation and effort in learning (Behavioral engagement), 2) Enjoyment and interest in learning mathematics (Emotional Engagement), and 3) Deep thinking and conceptual understanding (Cognitive Engagement). Most of the responses were positive in using Inductive Teaching Strategy with GeoGebra in learning mathematics (see Appendix A).

The result revealed that the active participation during the delivery of lessons and exploration of Geogebra at their home and beyond classroom activities showed a strong behavioral engagement. Similarly, the enjoyment and interest they expressed served as the evidence of their emotional engagement. This helped them in fostering motivation and a positive attitude towards mathematics learning. Furthermore, engaging in deeper understanding, problem-solving, and independent discovery of mathematical concepts promoted cognitive engagement.

Overall findings showed that the use of Inductive Teaching Strategy with GeoGebra made mathematics learning more interactive and enjoyable. It encouraged and inspired them to learn mathematics. Most of them shared that learning mathematics through Inductive Teaching Strategy with GeoGebra helped them to learn mathematics better and they desired to learn other topics through this approach too. Therefore, it was proven that the use of Inductive teaching Strategy with GeoGebra increased the level of engagement of Grade five Bhutanese students in learning mathematics.

Result of Classroom Observation

Classroom Observation was conducted to supplement and support the data findings from the achievement test and semi-structured interview. Classroom observation checklist was used to record the observation by observer and later, it was coded into themes aligned with the research objectives and research questions. The data collected from the classroom observation were analyzed under four themes: 1) Focused attention and serious engagement, 2) Active use of GeoGebra for conceptual understanding, 3) Participation and collaboration, and 4) Interest and motivation toward GeoGebra.

The result revealed that the Inductive Teaching Strategy with GeoGebra encouraged positive learning behaviors and it suggested that the Inductive Teaching Strategy with GeoGebra supported more student-centered, meaningful, and motivating learning experiences (see Appendix B).

Discussion

Students' Learning Achievement

The analysis of pre-test and post-test scores indicated measurable improvement in students' mathematical performance. All the students showed increased scores in the post-test in comparison to the pre-test scores. The students responded that the use of Inductive Teaching Strategy with GeoGebra helped them to understand the content better than the traditional method. The finding is parallel to the research findings of Kllogjeri, and Kllogjeri (2015) on the teaching with GeoGebra versus the traditional method. The findings from his study showed that the use of GeoGebra in teaching and learning processes causes much more increase in the level of knowledge and skills in mathematics than the traditional method used in the process.

This is aligned with the principles of constructivism theory. Owing to the need for a change of teaching strategies from the traditional method (Deductive Teaching Strategy) to more of a constructive method, This study proved that Inductive Teaching Strategy with tools like GeoGebra can be used to facilitate teaching and learning constructively. GeoGebra when used in Inductive Teaching Strategy provides the students with an opportunity to actively participate and experiment to construct their knowledge with the help of teachers.

According to this study, the use of Inductive Teaching Strategy with GeoGebra had a good influence on students' academic performance. The finding was parallel to the study conducted by Ansong, Wiafe, and Amankwah (2021) on the application of GeoGebra to improve academic performance of students in geometry. Their findings showed that there was a significant difference between the mean score of students who were taught using GeoGebra and those taught without the use of GeoGebra. It revealed that the use of GeoGebra has improved students' mathematics achievement.

Students' Engagement

Classroom observation and student interviews revealed that students were highly engaged when GeoGebra was integrated into inductive lessons. Students displayed curiosity, frequently asked questions, and explored mathematical concepts through interactive and hands-on activities. The finding was parallel to the study by Chalaune (2020). His study

on the effectiveness of GeoGebra in teaching school mathematics revealed that the use of GeoGebra is an effective tool to increase achievement, to promote curiosity, creativity, to make clear sense of concepts, and to encourage overall learning of students in mathematics. This approach promoted a student-centered environment in which learners took ownership of their learning.

Students expressed enthusiasm and interest toward using GeoGebra, indicating intrinsic motivation. Many students reported enjoying the lessons and feeling more confident and connected to the subject. These findings aligned with the constructivist learning theories that emphasize exploration, interaction, and autonomy. Thus, with all the positive opinions expressed by almost all the participants, the researcher concluded that the Inductive Teaching Strategy with GeoGebra was effective in teaching and learning of mathematics to grade five Bhutanese Students.

SUGGESTIONS AND RECOMMENDATIONS

For Teachers

1) As the findings from this study showed a positive impact on mathematics instruction, teachers may consider integrating GeoGebra into daily mathematics instruction, especially in topics like measurement.

2) This research showed that Inductive teaching strategy promotes engagement. As a result, teachers may apply Inductive Teaching strategies that promote inquiry, exploration, and reasoning rather than direct instruction alone.

3) Teachers may provide opportunities for students to use GeoGebra independently to reinforce learning at home or during free periods.

For School Leaders

1) School leaders may plan for professional development and training on the effective use of GeoGebra and Inductive Teaching Strategy.

2) Try to equip school with an adequate number of digital tools to ensure students have access to GeoGebra.

For Future Researchers

1) The study was limited to a section of 30 grade five Bhutanese students. Similar studies could be conducted with different grade levels, larger sample sizes, and longer duration to strengthen the findings.

2) A similar study can be conducted to investigate the long-term effects

of GeoGebra use on different mathematical contents.

Further research can be conducted to explore how GeoGebra can support learners with diverse needs and learning style.

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