THE INTEGRATION OF WEB-APPLICATIONS AND COLLABORATIVE LEARNING IN MATHEMATICS FOR GRADE FIVE BHUTANESE STUDENTS

BY

PEMA SELDON

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.....	.....
Asst. Prof. Kittitouch Soontornwipast, Ed.D.	Techameth Pianchana, Ph.D.
Examination Committee Chairperson	Member
	.....
	Asst. Prof. Nipaporn Sakulwongs, Ed.D.
	Member and Advisor

Approved by Graduate School

(Asst.Prof.Plt.Off.Vannee Sooksatra, D.Eng.)
Dean of Graduate School
December 13, 2022

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Pema Seldon

Researcher

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Abstract

The study was conducted to: (1) assess the learning achievement in mathematics of grade five Bhutanese students using web-applications and collaborative learning, and (2) examine the perception towards web-applications and collaborative learning in mathematics. The study was carried out in the academic year 2022 in one of the Lower Secondary Schools in Bhutan. The study presented mixed method research which included both qualitative study and quantitative study. The research instruments for the study consisted of lesson plans, learning achievement tests and the semi-structured interview.

The data from the students' learning achievement tests (pretest and posttest) were used for gathering quantitative data. As per the analysis, the mean score of the posttest (14.44) was higher than the mean score of pretest (10.24) with a mean difference of 4.20. Regarding the qualitative data, it was compiled by analyzing the data of the semi-structured interview which revealed the positive perception towards the intervention used by the researcher. All in all, these findings demonstrated how the integration of web-based applications and collaborative learning in mathematics had improved students' learning achievement and their perception. Thus, it can be recommended to consider the implementation of web-applications and collaborative learning in mathematics as well as other subjects.

(Total 120 pages)

Keywords: Web- Applications, Collaborative learning, Learning Achievement, Learners' Perception, Mathematics, Grade five students

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

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ABBREVIATIONS

Abbreviations	Meaning
BCSEA	Bhutan Council for School Examination and Assessment
PISA D	Programme for International Student Assessment for Development
STEM	Science, Technology, Engineering and Mathematics
REC	Royal Education Council
MoE	Ministry of Education
DCPD	Department of Curriculum and Professional Development
IOC	Item Objective Congruence
BBE	Bhutan Board of Examination
RCSC	Royal Civil Service Commission
SD	Standard Deviation

CHAPTER 1

INTRODUCTION

The essential components addressed in this chapter are the background and rationale of the research, research objectives, research questions, research hypothesis, scope and limitations. Additionally, it also provides the conceptual framework of the study, the expected outcomes and the operational definitions.

1.1 BACKGROUND AND RATIONALE OF THE STUDY

Bhutan, a small Himalayan country situated between the two giant countries (India and China) with a population of approximately seven hundred thousand. In spite of the country's size and its population, the monarchs have always given higher prominence to the education system. His Majesty in the Royal Kasho on Education Reform has stated that, the First King Gongsa Ugyen Wangchuck, despite the difficulties of his time in the twentieth century recognized the need of modern education in preparing Bhutan for the future and established schools as well as sent students to India for studies. It has also been stated that all kings have followed their father's footsteps in prioritizing education by building more schools, establishing tertiary institutions, and increasing student enrollment and teacher recruitment. Furthermore, His Majesty the Fifth King believes that it is necessary for the children to not only receive a world-class education, but also find meaningful and gratifying jobs that allow them to attain their dreams of better living conditions. (The Druk Gyalpo, 2021). According to Lhendup (2020), technology offers great potential and opportunity to enhance access to quality education, create employment opportunities, promote good governance through effective and reliable service delivery, develop and strengthen the private sector, and improve accountability and transparency.

Mathematics is a pertinent subject since it impacts every action that people do in their everyday lives. According to Quddusi (2018), quantitative evidence would be challenging to settle in our daily lives, had there been no numbers to use and likewise it would have been a difficult situation, without having to use specific times, measures, rates, salaries, tenders, discounts, claims, supplies, jobs, stock exchange, taxes, and other financial transactions. Yadav (2019) also stated that mathematics models natural phenomena, human behavior, and social systems, all of which are part of wide range of disciplines dealing with scientific data, measurements, and observations as well as reasoning, deduction, and evidence. Mathematics is an important component of human logic and intellect, as well as contributes to understanding the world and ourselves. As a result, mathematics can improve mental discipline, reasoning ability, inventiveness, critical thinking, problem-solving skills, ability to think abstractly or spatially, and effective communication skills (Importance of Maths, 2015, as cited in Role of Mathematics, 2022).

Considering the significance of the subject and its ability, the students must enhance their mathematical skills since it will have a great influence on future employment prospects. According to Audsley (2019), although some careers such as engineers, computer programmers, statisticians, actuaries, mathematics teachers, and even business managers appear to be extremely diverse, they all requires a very highly developed mathematical abilities. It is due to the analyzing and problem-solving abilities that employers desire people who are proficient in mathematics making mathematics essential in every aspect of life. However, the majority of students regard mathematics as a challenging subject because they think mathematics as a topic that requires a lot of practice and consider it as difficult to master since the beginning of their academics.

As stated by Gotz (2012, as cited in Summer, 2020), there is an unfavourable pattern for mathematics emerging from an emotional standpoint, which according to numerous surveys explains “in comparison to other disciplines, mathematics has a stronghold, and to love learning this subject is a rare occurrence”. Align to this, Dorji and Tshering (2020) have also stated that the Programme for International Student

Assessment Development (PISA-D) test conducted by Bhutan Council of Secondary Education (BCSEA) (2017, 2019) revealed the Bhutanese students performing much worse in mathematics than students from other Asian countries. They have also mentioned that despite the mathematics curriculum revised several times yet, there are indications of a number of problems and challenges in Bhutanese mathematics curriculum. In addition to this, Dorji and Tshering (2020) had also found out that owing to word problems in mathematics, students of grades four to twelve frequently fail to extrapolate, reason out, and grasp the patterns conveyed in word problems. There is also rigorous mathematics curriculum, which is so restrictive for teachers and students to use a variety of methods and solutions and furthermore, it is due to the rigid and prescriptive framework, which encourages the idea about curriculum linked with the assessment system is only to get admitted to higher grades or to get a job considering it the traditional paper-pencil test and wants it to be switched to a performance-based evaluation.

Therefore, integrating technology in addition to conventional techniques can be a fundamental requirement in this contemporary world of teaching and learning environment. There are also several technologies that are becoming increasingly ubiquitous in both online and onsite classrooms. The American University School of Education (2020), states that due to fast access to knowledge with technology, it can provide an exciting opportunity to learn quickly and then implement what one has learned into practice. Particularly in STEM (Science, Technology, Engineering & Math), it assists students to go deeper into challenging ideas and explore a set of concepts. Having students to use technology both inside and outside the classroom can guide to acquire the technical skills of 21st century, which is important for their future careers. Incorporating web-applications and collaborative learning instruction highlights a paradigm shift in classroom instruction, but can enable immersive experiences and dynamic types of interactivity improving student engagement and learning along with their higher-order thinking skills and creativity. It can simulate problems in a real-world setting, improves communication within and between classrooms, and provides students with a shared space to store the outcomes of their group work and model on their shared understanding of new concepts (Andrew,

2019). As stated by Reddy (2016), technology has the potential to deepen students' knowledge, pique their enthusiasm, and help them improve their arithmetic skills. Students are also motivated by technological instruments and given the opportunity to take an active role in their education; they can build their own learning strategies and understandings.

According to Wang (2017), when people obtain a new smartphone, they almost always download applications right away. Noticing this trend, the educators have created thousands of applications to utilize in their daily lives. There are numerous applications of educational activities on the internet, which can enable teachers and students from all over the world to communicate. Learning styles and learning preferences have also shifted due to the massive impact of information technology and the teachers must remain updated by embracing change in order to cater as per the current trend and needs of the students. Furthermore, encouraging students to adapt learning online is important because it can help them to cope up with the different learning environment in case any unwelcoming pandemic arises. Only technological skills with various web-applications have the ability to increase learning during such times. Hasting (2019), states that the web-applications have the ability to develop greater relationships and collaboration in the classroom, but they also provide effortless ways to connect with all students in order to create an engaging learning environment. Moreover, with this level of connectivity, students and teachers can study new subjects and communicate their ideas more swiftly.

Since almost all devices (smartphone, tablet and laptop) support the usage of web- applications and are seen to be beneficial in a collaborative situation (Schmid, Masson, & Hirsbrunner, 2013), the web-applications in education are playing a greater role and have grown in popularity. As stated by McLoughlin and Lee (2008, as cited in Theng & Mai, 2013), web-applications are more than just innovations that use digital technology to facilitate social interaction and information access. Their scope has expanded establishing global connections in a knowledge society enabling the creation of collaborative knowledge and the involvement in interconnected learning communities.

Some of the web-applications like Kahoot, google workspace, zoom, and quizzes serve as platforms that incorporate collaborative learning approaches that help to further engage the students to learn more relevant lessons and become more accountable. According to Motameni (2018), collaborative learning is a process of learning in which two or more individuals interact to generate meaning, investigate a topic, or enhance abilities. Collaborative work enhances social interaction, teamwork, and cultural variety among students, allowing them to apply what they've learned while also developing their analytical and judgment skills (Du & Martínez-Rivera, 2014). As stated by the concept that students learn more effectively by doing something active rather than only watching and listening has long been recognized, and collaborative learning is an active learning strategy. Using cooperative learning can facilitate students to collaborate to solve problems and enhance student outcomes (Sung & Hwang 2013).

Tezer and Cimsir (2017) stated that web-based learning environments are educational paradigms in which teaching and learning activities are autonomously managed, and the computer is used as a tool for discovery, inquiry, and communication that occurs through the internet between learners–learners and learners–educators. According to Tezer, Yildiz, Bozkurt, and Tangul (2019), the findings of teacher research were also in favour of "Web-supported Learning Environments" because it demonstrated that it features both onsite and online material, making learning independent of time, independent of learning at any time they wish, and supported the collaborative learning, proving a great advantage. Since teachers are the medium through which students acquire knowledge, thus teachers' success in learning mathematics utilizing a web-based learning environment could have strengthened their teaching skills, which may improve students' learning in mathematics since this web-based learning environment acknowledges the incorporation of collaborative learning with peers and teachers as well.

On this account as it was said by Tsuei (2012), Computer Supported Collaborative Learning (CSCL) instills information about the problem-solving process, which may improve mathematical thinking, and because it encourages

interaction with virtual manipulatives, this environment fosters mathematics web-based collaborative learning. Furthermore, the findings of the technique used on primary school students revealed a higher rate of increase in maths aptitude scores, which was especially relevant to low-achieving and low self-concept students because these students are usually hesitant to try solving unfamiliar maths problems for fear of failing and appearing foolish in class. However, the CSCL environment gives students more opportunities to contribute than in the traditional context and the students also reported feeling more at ease, being able to concentrate, and having enough time for possible solutions.

Thus, seeing the difficulties in learning mathematics as well as the poor performance rate of the Bhutanese students, this study intends to find the improvement in students' learning outcome and their contentment by integrating web-applications and collaborative learning. As stated by Andrew (2019), Computer-supported collaborative learning (CSCL) enables working together and sharing ideas in pairs or in groups, as well as it can further help to disseminate their knowledge and expertise among community members, which can expose them to strengthen their learning and prepare them for work in the future.

1.2 RESEARCH OBJECTIVES

1.2.1 To assess the learning achievement in mathematics of grade five Bhutanese students' using web-applications and collaborative learning.

1.2.2 To examine grade five Bhutanese students' perception towards web-applications and collaborative learning in learning mathematics.

1.3 RESEARCH QUESTIONS

1.3.1 Would the integration of web-applications and collaborative learning improve the learning achievement of grade five Bhutanese students in mathematics?

1.3.2 What was the perception of grade five Bhutanese students towards web-applications and collaborative learning in learning mathematics?

1.4 RESEARCH HYPOTHESIS

1.4.1 Grade five Bhutanese students' learning achievement would be improved by the integration of web-applications and collaborative learning in mathematics.

1.4.2 Web-applications and collaborative learning in mathematics would make the students perceive the subject positively.

1.5 SCOPE OF THE STUDY

1.5.1 Location of the study

The schools in Bhutan are categorized into 4 levels namely; 1) Primary School (grade PP-6), 2) Lower Secondary School (grade PP- 8), 3) Middle Secondary School (grade PP- 10) and 4) Higher Secondary School (grade PP- 12). Regarding this research study, it was carried out in one of the Lower Secondary Schools situated in the Southern foothills of Bhutan. The school falls under Phuentsholing Thromde, which is the big commercial hub in Bhutan.

1.5.2 Population and Sample

There were four sections of grade five and the researcher considered the population of only one section using a cluster random sampling. In a class, there were sum of 31 students with mixed abilities and genders, who were the participants for the research. The student participants were of varying backgrounds, mathematics proficiency and of different age groups ranging from 10- 12 years.

1.5.3 Content of the Study

To carry out the research, the researcher focused on teaching one of the chapters (Decimal Computation) from grade five mathematics textbook, which was developed by the Royal Education Council (REC) of Bhutan. The chapter was divided into four subtopics and was taught by the researcher to the students for the understanding of the given concept. However, in order to do the findings of the research, a pretest was conducted prior to teaching followed by a posttest after the interventions was used to teach the concept of Decimal Computation.

Table 1.1 Table of content for the lesson

Lesson Plan	Topic	Time
I	Pre-Test Exploring Decimal Number (Thousandths)	First August, 2022
II	Adding and Subtracting Decimals	Second week of August
III	Adding Decimal Thousandths	Third week of August, 2022
IV	Subtracting Decimal Thousandths Post-Test	Fourth week of August, 2022

1.5.4 Time Frame

The study was conducted from the beginning of this academic year 2022 and after the research proposal, the researcher went for data collection, which took about four weeks to complete. The researcher taught one lesson per week considering each lecture of 90 minutes and thus over the course of a week, the researcher covered a lesson in two 45 minutes with each period lasting for 45 minutes. The researcher completed the teaching in mathematics within the course of four weeks, utilizing Google slide application with Slido for eight periods and the data was collected by the end of August of 2022. 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	2022	March	2022
Research Proposal	April	2022	July	2022
Data Collection	August	2022	August	2022
Data Analysis	Sept	2022	Sept	2022
Final Defense	October			2022

1.6 LIMITATIONS OF THE STUDY

Every research has its limitations due to the impact of the particular study they make. So, the following are the limitations to this study research:

1.6.1 Only two web-applications were used in the study to educate a part of grade five students. As a result, the findings cannot be generalized with all the web-applications.

1.6.2 The study's content was confined to only one topic from the textbook of mathematics subject from grade five and so cannot be generalized to all the topics.

1.7 CONCEPTUAL FRAMEWORK OF THE STUDY

The research study included two variables namely; independent variable and dependent variable. In this research the integration of web-applications and collaborative learning were the independent variables, whereas the learning achievement of students and their perception of learning mathematics integrated with web-applications and collaborative learning were the dependent variables. The framework is illustrated in figure 1.1.

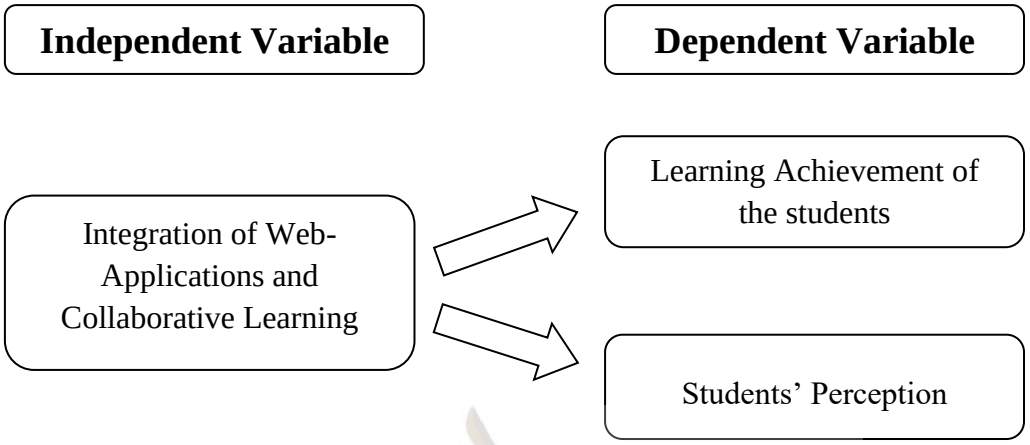

Figure 1.1 Illustration of the Independent variables and Dependent variables.

1.8 OPERATIONAL DEFINITIONS

Web-Applications and Collaborative Learning: There are many web-applications available both offline and online. Different applications are meant for different purposes and can be utilized as per the need and reliability. In Bhutan, the schools have been provided with free access to Google (applications) and its use was found prominent for teaching and learning only after the pandemic. However in this research the web-applications used were Google slide and Slido for the research participants to learn mathematics (Decimal Computation). Regarding the collaborative learning, it is a teaching method in which the students get together to study as a group and assist one another in achieving a common goal (Fu & Hwang, 2018). In this study, the researcher used it for teaching and to carry out activity using web-applications and the students were either asked to do the work in pairs or in groups depending upon the type of activity.

Learning Achievement refers to the success of the research participants in learning mathematics, which can be identified from their achievement test scores of pretest and posttest in mathematics. It can also refer to the improvement in students' learning achievement after learning mathematics (decimal computation) using web-

applications and collaborative learning. This is to be assessed by conducting learning achievement tests including pretest and posttest.

Learners' Perception refers to the students' perspective of learning derived from their involvement, which is based on their enthusiasm and engagement in learning mathematics by integrating web-applications and collaborative learning. After the intervention, data was obtained from the participants using the semi-structured interview. The outcome of the interview was to determine how satisfied the students were with the interventions, in terms of learning mathematics (Decimal Computation), which covered the students' enthusiastic responses.

Mathematics refers to the major subject being taught to all the students from pre-primary grade and above. Mathematics in education imparts the knowledge to students related to numbers and operations. This study of research focuses on learning mathematics on decimal computation. Decimal has been used in our everyday tasks and skills like measuring or the handling of money especially when greater accuracy is required than whole numbers can serve. In the research, the study was based on the learning of Decimal computation, which referred to the four mathematical operations (addition, subtraction, multiplication and division) involving decimals, however, only one chapter with two operations (adding and subtracting decimals) were taught for this study.

Grade 5 Students refers to the Bhutanese students studying in fifth standard ranging within the age group from 10 to 12 years old. They were the participants for the research study.

1.9 SIGNIFICANCE OF THE STUDY

The integration of web applications and collaborative learning in mathematics can be a good idea to introduce in the classroom as well as online. It has the potential to assist the teacher and facilitate the students' learning and participation, which can help to improve students' learning motivation and performance. This indicates to consider it as one of the most important methods for teaching mathematics because:

1) The study has had a positive impact on the learning achievement of grade five students with the integration of web-applications and collaborative learning.

2) The study would also provide mathematics teachers of Bhutan with an alternative tool and teaching strategy useful for quality teaching.

CHAPTER 2

LITERATURE REVIEW

This chapter provides the concept of mathematics along with the overview of the mathematics curriculum in Bhutan. It also includes the concept of web applications and collaborative learning. Nevertheless, it also contains their significance in the education system of Bhutan; impact of learning mathematics using web applications with collaborative learning and as well as its future in the education system. Moreover, the study also covers related theories applied and the related research studies, which will contribute in the better understanding of the study in teaching and learning mathematics in the schools.

2.1 CONCEPT OF MATHEMATICS

The science of mathematics is vital to every facet of our lives since it is connected to all occurrences of natural phenomena and the very existence of all lives. Also, everything in our lives including mobile devices, computers, softwares, ancient and contemporary architecture, art, money, engineering, and even sports are constructed based on it. Mathematics has been at the forefront of civilized society since the beginning of history, and even the most ancient civilizations have used it (Hom & Gordon, 2021). Mathematics is therefore an essential subject, which gradually took priority in the Bhutanese Education System considering it as a significant and major subject that every student must learn.

Similarly, as per the YouTube video of the Free Animated Education (2017), Galileo, the famous philosopher has observed that the rules of nature are written in the language of mathematics. Maths, like English, is a human language since it allows individuals to communicate with each other and even in ancient times, the people were required to conduct trade, build pyramids, and measure long distances. It is the most magnificent invention of the human brain and a strong assistance to the human

mind. Engineers also use maths to develop infrastructure and telecommunications, doctors use maths to prescribe the proper quantity of medicine, and researchers use maths to substantiate their findings. According to Liljedahl, Santos-Trigo, Malaspina, and Bruder (2016), mathematics is essential for problem-solving, logical reasoning, and creative thinking. As a result, knowing arithmetic aids in the development of precise thinking, which is required in all aspects of life. Mathematical thinking not only helps to develop the young minds, but also inspires students to envision and build a future that does not yet exist. Understanding has no bounds, and mathematics aspires to the highest level of comprehension, which will undoubtedly drive them to the next level.

According to Maki, Zaslofksy, Ebbesmeyer, and Boatman (2021), early mathematics proficiency has been found to predict subsequent success on more difficult maths skills. Importantly, students who were having academic difficulties in school were more likely to drop out. However, children who excelled in mathematics showed better preparedness for subsequent jobs and were more likely to be employed. These large mathematics proficiency outcomes highlight the need for academic assistance in schools to ensure that students display the abilities required for challenging academic activities as well as subsequent independent life. The Principles and Standards for School Mathematics (2000, as cited in Larson, 2018) states that the Council has declared explicitly the students must acquire mathematics, and that mathematics must be taught as a result and for reasons other than "necessary mathematics".

Since it can be understood that everything around is connected to the science of mathematics, learning mathematics can help students comprehend how the world works. Thereby through mathematics, students can be able to apply maths strategies to use data to form logical conclusions, as well as apply the mathematical knowledge and skills to create a real-life impact. Hence, this study will help the researcher to find out the learning achievement and the perception of the students in learning mathematics through a different approach that they have not yet used.

2.2 MATHEMATICS CURRICULUM IN BHUTAN

Bhutan has made far significant progress in defining and rethinking its educational programs, policies, and methodologies. The introduction of more flexible and up-to-date academic courses has formed a more applicable and contextualized education system (Subba et al., 2019). Despite the three key divisions of Bhutan's education system, namely general education, monastic education, and non-formal education, general education is widely recognized as the formal educational unit and as the most essential (Gyeltshen & Dorji, 2020). Rinchhen (2013) stated that in 1959, the Bhutanese government had established roughly 20 government schools. The majority of the instructors were recruited from India, hence the curriculum and materials too were borrowed from there.

Similarly, Namgyel (2011, as cited in Tshewang, 2015), stated that the Bhutanese schools used to follow Anglo-Indian-influenced school curricula until the 1980s curriculum reform. This was mostly owing to the fact that it was an adjustment and learning time. The curriculum is the most important component of any educational system, and the learning environment. The change of curriculum with the improvement in it will enhance the quality of classroom instruction and inspire students to study, resulting in an overall improvement in the country's educational quality.

According to the Ministry of Education (MoE, 2009, as cited in Dolma, 2016), the Ministry decided to evaluate the mathematics curriculum in response to the 2003 National Educational Assessment, based on recommendations from independent external consultants. Dr. McLean and Dr. Hiddleston, from the United Kingdom. They were the first group of academics to call for an immediate review and revision of the mathematics curriculum. As per the Ministry of Education (2007), based on the recommendation, a team of Canadian consultants and their Bhutanese counterparts began constructing Chapter 2: Context 21 the mathematics curriculum framework from Class PP to class 12 based on these ideas later in 2005.

The Royal Education Council (REC) revised the Mathematics textbooks for Classes PP to VI in compliance with the National Curriculum Conference 2016 resolution to examine the curriculum from Classes PP to XII and decrease its bulkiness. The circular states that "no significant modifications were made to the textbooks' contents, nor any new topics incorporated in the reprint/print 2017 textbooks; however, certain lessons were removed, and certain units were reconstructed without losing the core essence" (Cheki, 2018). Later, according to the Department of Curriculum and Professional Development (DCPD, 2022), the new Mathematics Curriculum Framework 2021 was developed with a goal to develop learners with a mathematical mind- set and skill vital for the development of competent mathematician, statistician and data scientist citizens.

This study is basically concerned with finding out the level of students' learning achievement and perceptions following the incorporation of web-applications and collaborative learning into maths lessons. It will be designed to foster a positive mentality toward mathematics and to build competent mathematical abilities in comprehending the global perspectives, which is the main goal behind the mathematics curriculum of Bhutan.

2.2.1 Application of Technology in Mathematics

Technology addresses varied ways for the learners to gather information and enhance their learning, thereby indicating the integration of technologies into the content-specific curricula as an important tool. The important aspects of education like communication, creativity, and critical thinking have taken on new significance as a result of technological developments (Drake & Reid, 2018). With pandemic into its mutation and progress to a never ending situation, the Royal Education Council (REC) framed a New Normal Curriculum for the educational institution to run smoothly with a goal to create opportunities and learning experiences for students (REC, 2021). Hence, teachers were compelled to continue educating children remotely, which indicates a huge transformation to the instruction system, where it required the skills for the teachers to bring classrooms online. They used various

social media applications (Wechat, Whatsapp and Telegram) and some other web applications like Google workspace (Google classroom, Meet, Google slides), Zoom, Mentimeter and Quizzes.

In the iSherig-2 Education ICT Master Plan 2019-2023 (2019), they urge the teachers and students to to use their digital pedagogical knowledge and abilities to access electronic materials available on a platform. According to Education in Emergency (EiE) During COVID-19 Report, 74.48% of the student respondents have enjoyed and appreciated the effectiveness of being engaged in online learning. It also instilled in them the values of learning independently rather than relying on teachers all the time (Ministry of Education, Helvatas Bhutan, & Unicef Bhutan, 2021). As stated in the DCPD (2022), Students comprehended mathematical concepts by using visuals, simulations, and representations provided by the ICT technology. Nevertheless, it can provide each student with a learning platform to design personalized learning where they can progress at their own pace and also assess their own learning. ICT tools can also help them to communicate ideas and collaborate with one another as part of the knowledge-building process. Thus, making use of web-applications and collaborative learning in mathematics, the researcher will find out the student's level of learning achievement and their perception towards these interventions of learning.

2.2.2 Decimals

Numbers can be categorized into several sorts in mathematics, such as real numbers, natural numbers, whole numbers, rational numbers, and so on. Among them are decimal numbers. It's the most common way to express both integer and non-integer values. Decimals are a form of number in Algebra that has a whole number and a fractional part separated by a decimal point. People utilize decimals in a variety of circumstances every day. In fact, decimal numbers are utilized when a situation requires greater precision than a whole number. Students benefit from decimals since they will use them frequently in their calculations, and even when using a calculator, fractions, proportions, and percentages are all converted to decimals.

Tian, Braithwaite, and Siegler (2021), claims that despite its importance, the researchers have paid less attention to decimal arithmetic than fraction arithmetic. As per Hurst and Cordes (2018), only 77% of fourth and fifth grade students got the decimal addition problems correctly answered, which were of decimals tenths and hundredths. Their poor performance in decimal arithmetic is due to their lack of conceptual comprehension of decimal place values and decimal arithmetic. According to Braithwaite, McMullen, and Hurst (2022), many students struggle with rational number arithmetic which includes both fraction and decimals. He also mentioned about sixth graders correctly answering only 57% of decimal arithmetic problems.

As mentioned in Bay-Williams, SanGiovanni, Martinie, and Suh (2021), the same goes with the decimal addition and subtraction, which is rarely liked or well understood, leaving the students perplexed and ill-equipped for the flexibility and understanding they require for success in algebra as well as in manipulating numbers in their own life experiences. Therefore, the researcher will study the learning of this topic in mathematics integrating web- applications and collaborative learning.

2.3 CONCEPT OF WEB-APPLICATIONS AND COLLABORATIVE LEARNING

2.3.1 WEB-APPLICATIONS

There are many applications being introduced in today's world and based on the recommendations, conveniences and its effectiveness, the applications are downloaded and utilized. Nevertheless, the Ministry of Education all over the world is always seeking to increase educational quality achievement and to guarantee the relevancy of curriculum to current demands, it is regularly evaluated, monitored, and updated (Ahmad, Hamzah, Hassan, & Rohanai, 2020). There are countless applications available for desktop and mobile phones and some of the applications have to be installed for further use. They are desktop applications, which run locally in the desktop or laptop, whereas web applications are a program that requires a web

browser to run and the internet for data or resource transfer (Rana, 2021). However this research will focus on the use of web applications since they are ubiquitously gaining more popularity in the technology driven world and interestingly they are designed to run on a device such as a computer, phone and tablet. According to Sawant (2017), every computer and mobile device comes with some applications such as a web browser and media player but the users can download a variety of other free applications including apps for reading, research, and reference, taking notes and writing, content production, social networking, and communication.

Therefore, many web- applications are available today and are being used by different organizations including Education for teaching and learning purposes but the majority of the population prefers Google Apps. Likewise, in Bhutan also the Google Apps are commonly used in many of the government and private organizations. According to the Prime Minister of Bhutan (as cited in Zangpo, 2014), the initiative to introduce Google Apps in Bhutan is owing to the secure email identity (inability to be hacked) as well as the extremely effective spam filter. Moreover, Google Apps allows users to save and share documents that will be accessible through electronic devices. As stated by Gibb (2022), Google Apps includes Google Gmail, Google Docs, Google Sheets, Google Slides, online storage, and other applications with other features like calendar sharing. These web- applications allow all team members to connect and edit the same copy of a document at the same time. In this study, the researcher will use Google slides with Slido for learning mathematics.

Google Slide

According to Edwards (2020), Google Slides is a presentation program, offering various attractive predesigned templates together to create engaging visual presentations to support in an oral presentation. There is an ability to auto save and also to lock access, which is a great security feature to just enable viewing or comment, so that the students cannot alter the work. Additionally the presentation can be enabled to be used offline and can also be shared directly with students or teams using a simple link, sent through different means including email, text and other

social media platforms. Consequently, allowing students to work collaboratively online or offline on a project. As stated by Ahmad et al. (2020), the Google slide is one of the teaching aids used to facilitate teachers and students in the Teaching and Learning (T&L) process. On this point the use of Google Slide with Slido can further strengthen the T&L process. Holub (2020) has stated that with Slido for Google Slides, can add interactive elements to the presentation like; a) add a live poll; b) add a quiz poll and c) display audience Q&A. According to Edwards (2021), slido supports engaging quiet students in the class thus encouraging all the students to participate and having heard all perspectives equally. Slido integrated into Google slide presentations can also allow students to view the instant opinion or insights of the questions they answered and can give inspiration on interactive ideas, which can drive them to engage actively in order to properly understand the concept.

According to Gulomjonovich (2021), Google presentations is a constructive tool easy to create presentations, edit, and collaborate on presentations, allowing the student and others (co-authors) to update files from their personal computers, smart phones, tablets, and laptops in real-time. Technology in education is meant to give students technological and collaborative tools in order to promote better academic achievements, not only to increase students' learning. As per the data, the use of Google slides as an online collaborative tool enhances student participation in online learning, and most of the students prefer using such programs for future courses since they can benefit from the teacher's instant comments online and promote access to course resources (Leng, Sheng, Yeap, & Tan, 2021). As per Slidesgo (2022), the following are the main advantages of this program:

1) Easy to access since the presentations can be stored in the cloud (Google drive), without having to carry external devices.

2) Encourages teamwork, in which it allows multiple people to view and/or edit the document simultaneously as per the access allowed.

3) Compatible with other Google applications (Google Sheets, Google Photos and even multimedia content from YouTube).

4) Instant auto-saving giving users 100% surety that the work will not be lost.

5) Free for Gmail account users. In Bhutan, the Ministry of Education has provided all the schools with the Gmail account for teachers and students.

Since the Google slide and Slido provides a very reliable platform on interactive learning, the researcher designed a lesson in the Google slide to make students actively take part in responding lesson related questions through Slido and then to do the tasks in Google slide in peers or in groups. Hence, it greatly helped the researcher to find out students' level of learning achievement and the perception towards learning mathematics using Google slide and Slido.

2.3.2 COLLABORATIVE LEARNING

According to Ibrahim (2016), the major goal of an active and engaging teaching-learning process should be to help students discover the excitement of inquiry and learning, which leads to increased confidence in their own abilities. The application of modern technologies and educational software is an important part of today's educational process. There are a lot of changes happening to instructional techniques that include comprehensive involvement, collaborative reflection, and the building of collective knowledge that leads to better learning and achievement.

Duta and Martínez-Rivera (2014) said that today, technology has influenced practically every part of our lives, from commerce to education. Many people's everyday lives have been altered as a result of their impact. Human relationships are deteriorating, as opposed to previous generations. Children may be seen trapped in the room, isolating themselves from what is happening beyond the closed doors. So, if in education the technology can be used to groom the human connection through teaching and learning, it will be an opportunity for the students to learn a lot more than they can learn alone. This is how web- applications can become more interactive, when used in collaborating learning.

As explained by Lahann and Lambdin (2020), in collaborative learning (CL), a group of students learn by sharing ideas, solving problems, or achieving a shared objective. Ludvigsen et al. (2015, as cited in Schwarz, Masson, & Hirsbrunner, 2021), states that Ministries of Education believes that developing collaborative skills plays an important part in life and can help to improve learning and development. It can also support a collaborative learning environment in enhancing mobility, coordination, communication and organization of materials, and interactivity (Zurita & Nussbaum, 2004; Lai & Wu, 2006; as cited in Huang, Y., Jeng, & Huang, T., 2009). Moreso, it inculcates intellectual synergy from working together on a task and developing social stimulus through group participation, thereby leading to improved comprehension and new understanding.

However, there can be certain challenges faced by the teacher and the students during the process of doing collaborative activities. Shea (2018) claims that students have trouble allocating work among group members, scheduling meetings because some students must travel a great distance, some are irresponsible and dominating who either monopolize the work or pressure peers to put their names on the group reports, some superior students dislike having weaker and lazy students, and when allocating work, it prevents them from fully understanding the exercise. According to WNET Education (2022), students require assistance and may need reassurance that they can get along with others by encouraging groups to:

1) Genuinely listening to the member will boost the group's self-assurance, acceptance, and achievement. Paying attention helps to comprehend and appreciate how group members feel and think.

2) Defining responsibilities by agreeing on who does what will lead them to further collaboration and guide on with their tasks.

3) Make everyone feel valued and motivated by highlighting their unique abilities rather than coasting on another member's skills.

4) Model excellence by helping each other. If anyone falls short of the group's expectations, others can support and encourage them to improve. Importantly, refrain from making negative comments on each other's thoughts and views.

According to Retnowati, Ayres, and Sweller (2017), collaboration was more productive than independent learning of problem-solving in mathematics, especially for more complicated issues. Students collaborate within groups to do the given tasks and they must comprehend the topic to which they want to contribute. They are also given time to express and analyze the group's views with one another in order to ensure the task is not only completed but also comprehended. These interactions allow students in developing self-management skills (Laal & Ghodsi, 2012). Vogel, Kollar, Ufer, Reichersdorfer, Reiss, and Fischer (2016) have justified that if team members communicate intelligently about one other's contributions, students are likely to get the most from their collaboration, which indicates the constructive activities and dialogic transactivity produced by either the learner or the learning partner, which explains the positive effects of collaboration learning.

Therefore, providing a collaborative learning activity for students and to do it in the Google slide will help the researcher in finding out the level of learning achievement as well as the perceptions towards learning mathematics collaboratively.

2.4 FRAMEWORK FOR TEACHING MATHEMATICS INTEGRATED WITH WEB-APPLICATIONS AND COLLABORATIVE LEARNING

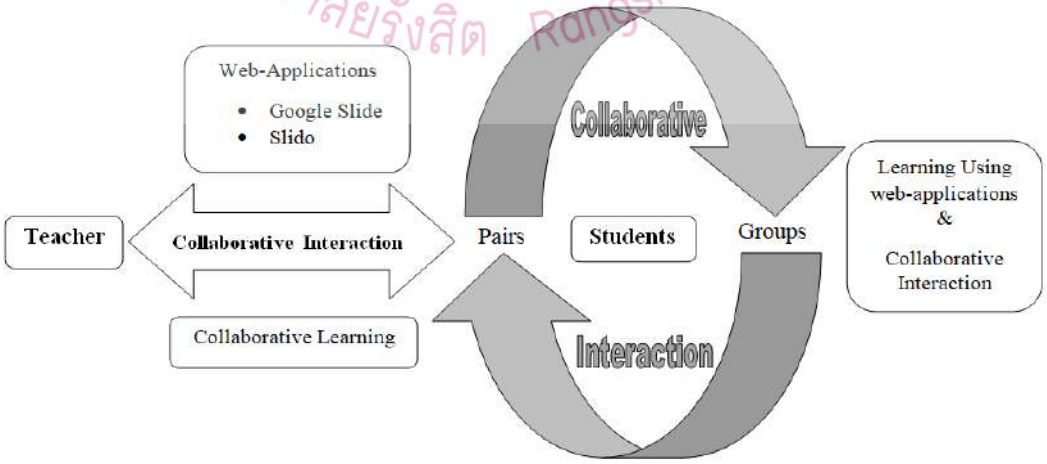

Figure 2.1 Framework of Web- Applications and Collaborative Learning supporting Learning Environment.

Fig 2.1 presents the framework proposed for the teacher and students to be involved in the teaching and learning environment. It shows that the teacher will use two web- applications namely Google slide and Slido. Both are collaborative tools and according to Al-Samarraie & Saeed (2018), these interactive technology platforms can make a significant contribution to students' competence growth, enhancing their perceptions of their capacities to participate in collaborative activities in these settings. It is predicted that using it will help to advance aspects of the cognitive, emotional, spatial, and group levels, which may, in turn, cause significant changes in the roles and behaviors of the instructor and the students. Hence using the Google slide, the teacher will do the presentation of the lesson and gradually in between the lessons; the students will have a responding activity, where they will use Slido. Since the Google slide will be linked to the Slido, students' responses from the Slido will pop- up instantly when they submit their responses.

There will also be separate activities for students to do in groups on the Google slide. Once they enter that slide, they can get connected online with their members to complete the tasks together by discussing in groups. As stated by Upchurch (2018), Google Slide is highly effective for collaborative projects as it enables numerous users to collaborate on a presentation from various places at same time. In order to do the work collaboratively, each member can be assigned with their share of the content but allowing everyone to view and comment on each other's work. The teacher will also provide a home assignment related to the lesson but can provide more practice in using the Google slide and doing the work together.

2.5 IMPACT OF LEARNING MATHEMATICS INTEGRATED WITH WEB- APPLICATIONS AND COLLABORATIVE LEARNING

Among the disciplines taught to students in Bhutan, along with English and Dzongkha, Mathematics remains the major subject of learning for the students. According to Palden (Kuensel, 2015), the officials from Bhutan's Council for School

Examination and Assessment (BCSEA) reported that grade ten students had the worst class ten result in the previous eight years, with almost 30% of students failing mathematics, only 4% of the students failed the subject the previous year. The mean score in mathematics reflected the quality of the students' achievement earlier was 55.79, but in the 2014 board exam it was 51.42, the lowest of all the subjects. However, according to Dukpa (2014), he found out that with regard to students' performance in mathematics, all studies conducted in Bhutan have consistently illustrated the low levels of learning leading one research study, which boldly concluded that there is no disagreement over student's low levels of learning across grades and their lack of life readiness.

There are many researchers, studying the performance and attitudes of the students towards mathematics. The deteriorating performance is seemingly a great concern making it important to know that the students need to be taught more effectively. According to Saidin, Halim, and Yahaya (2015), lessons that are assisted by technology will lead to more innovative types of teaching and learning. This is due to the fact that the use of technology incorporates real-world challenges, current informational resources, conceptual simulations, and communication with expertise in the field. It is an undeniable fact that students are digital natives, and their learning interests are also centered on technology.

According to (Ibrahim, 2016), learning by integrating technology can create user-friendly working environments, individual or group work, creative and competitive spirit stimulation through the effort to use diverse technologies and visual support that provides rapid understanding of even complex concepts. Consequently, students can learn by exploring and adjusting various settings and numbers in a systematic, mathematical manner. According to Goos (n.d.), if one considers mathematics to be a required knowledge to be taught, then technology's role in this process is essentially that of an efficiency tool that assists the students in performing the mathematics more quickly. If we regard technical tools as offering access to new understandings of relationships, processes, and purposes, then technology's role is similar to a conceptual building kit.

The advantages of web-application combined with the related communication and social interaction can help students learn to pose difficulties and provide their own explanations because as explained by Sarwar, Zulfiqar, Aziz, and Chandia (2018), students generate more knowledge and information in the shared setting, where they are encouraged to actively participate and collaborate in sharing their experiences. Moreso, the emphasis on the collaborative aspect has the potential to promote the contradiction and validation of ideas and procedures, which allows students to effortlessly navigate between tangible and digital resources. According to Schrader (2015), varying upcoming technologies are considered as efficient collaborative learning mechanisms, allowing students to receive learning assistance in the areas of developing creative thinking, sharing resources, and competence in a virtual network. Teachers can use applications as tools to modify the learning experience and provide students with new opportunities to engage with mathematics (Calder & Murphy, 2018).

Thus, as claimed by various other researchers on the positive impact of integrating web applications and collaborative learning, the researcher in this study will further find out the impact from the level of students' learning achievement using the pretest and posttest conducted to the participants. Nevertheless, the semi-structured interview was also carried out to gather the information on the perceptions of learning mathematics integrated with web-applications and collaborative learning. According to Solso (2008, as cited in Wardani, 2019), perception is the processing of experience that necessitates a high level of cognitive level. Any knowledge or experiences encountered are processed depending on the sensory stimulus of their education, culture, religion and even the person with whom they were present. As a result, their experiences take on new significance. Hence, students will encounter a new experience in their learning of mathematics integrating the web- applications and collaborative learning.

2.6 TREND TO EDUCATION: WEB APPLICATIONS AND COLLABORATIVE LEARNING

Prior to the introduction of technology in education, students depended on books to learn about the world. Books were the source of information, and teachers were the vehicle through which knowledge and information were disseminated. However, the growing use of technology has made the world accessible to anyone with the click of a mouse. Everything became easier and more possible as technology advanced. In 2016, the Department of Curriculum and Professional Development, formerly the Royal Education Council of Bhutan, began creating the new curriculum, which promoted a new approach of online teaching and learning in addition to the traditional method (Wangdi, 2021).

The COVID-19 epidemic, however, enabled the more use of technology which then resulted in replacing the long-used traditional method of lecture with chalk and chalkboard. It was mainly due to the pandemic, which prompted all the universities, institutions, and schools across the world to make modifications in their class delivering systems (Zhou et al., 2020). Education system could not be halted and the schools resorted to remote teaching using online learning platforms. Alike to many other countries, teachers in Bhutan were also compelled to replace the instructional time-loss through online teaching (Bergdahl & Nouri, 2020).

According to the Education Monitoring Division (Ministry of Education, 2021) the report on Education in Emergency (EiE) During COVID-19, mentions the use of numerous emergency approach like Self-Instructional Materials (SIM), video courses on air (television and radio), use of Google Classroom as well as social media for online teaching. Technology became a necessity, which encouraged society (teachers, parents and students) to explore and gain new ideas on using various applications. Dendup (2019) stated that the majority of the students can use various modes of applications to search for relevant information, which encourages self-

learning and sharing the learning responsibilities. This encourages a student- centered learning environment.

With various web applications available online in the contemporary world, students get to learn through interacting with their peers, which provides an opportunity to gain more knowledge and experience and instill the sense of collaboration. Today, technology has advanced to the point where it now drives the growth of businesses, and they improve their performance by hiring tech-savvy workers to assist with their operations. Schools are a great learning environment for future employees because they provide a setting where the curriculum can be combined with technology through resources, facilities, places, and even modules that can improve students' knowledge and abilities. Using technology in their everyday studies has the potential to benefit them more than it has the potential to damage them.

In the webpage of SoftwareSuggest (n.d.), the technology in education can assist schools in helping to keep up with the times and making education more relevant, intriguing, and efficient. There are several interesting possibilities as we explore the different applications of technology in schools.

1) Global Learning and Exchange Platforms

Traditional student exchange programs can be expensive. However, global online learning systems connect students from all around the world and help them study more effectively. Students can learn a lot through video conferencing.

2) Paperless Classrooms

Climate change is a genuine thing and it is more crucial than ever to encourage children to be more environmentally conscious and considerate. One approach to accomplish this is to reduce the amount of paper used. Schools may save money and the environment by distributing instructional materials over email and cloud-based tools such as Google Drive.

3) Virtual Reality in the Classroom

There is no reason to abandon virtual reality in the classroom when it is steadily permeating every aspect of our life. There is no doubt that if students can imitate real-life situations in a virtual world, they will learn more successfully because field trips aren't always possible but augmented reality in the classroom can be a beneficial tool.

4) Data-Powered Personalized Education

Data collected on students can assist teachers in building a more personalized approach to educating and developing a student. There are several online tests and assessment systems that could assist teachers in determining their students' strengths and weaknesses and in determining which way of learning the students are most likely to react to.

5) Self-Learning and Development

Technology can generate a reader profile for a student and automatically recommend books, articles, movies, and videos on topics of their interest. According to Saxena & Oswal, (n.d.), technology can be a powerful tool for providing the required education, particularly during humanitarian crises such as war or natural disasters. Furthermore, individuals with developmental and cognitive difficulties will have an even higher need for technological help. If this support can reach a wider range of students with special needs, it can offer hope and motivation to reach out to the world in a more inclusive manner.

2.7 RELATED LEARNING THEORIES

The ability of learners varies with individual and the learning theories make it easier for the teachers to be guided with appropriate strategies in understanding the learner and applying the appropriate tools in enhancing learners' achievement. The learning theories are hence very important in the education system since it gives deeper insights of the students prior to teaching. According to Fives and Buehl (2014), teachers' personal theories of teaching and learning influence their

instructional methods, and Harasim (2017) states that learning theory is one that seeks "to assist us understand both how information is formed and how people learn."

2.7.1 COLLABORATIVE LEARNING THEORY

Tucker (2014) explains that Collaborative Learning theory, in contrast to traditional Learning theory, is aligned with current learning theories, which involves learners working collaboratively to solve a problem or work together on learning tasks. As Bozkurt (2017) justifies that knowledge involves interaction and people cannot grasp an individual's cognitive development without first understanding the social setting in which the individual grows up. As a result, it recognizes the importance of both social interaction and individuality in the learning of mathematics. According to Taylor (2015), he emphasizes the importance of engaging students in discussions, whether it is leaded by the teacher in question and answer sessions or student-directed group activities, allowing them to express their ideas and assess their viability against the perspectives of other students. Children can enhance social inquiry abilities through collaborative learning, especially in small groups, such as active and sympathetic listening, speaking by taking turns, contributing ideas on a topic or issue, and reaching a consensus solution or conclusion.

The collaborative learning theory is deeply rooted with the work of Lev Vygotsky. According to him, learners subsequently succeed in performing a new activity with the help of another person, and eventually internalize this ability to do it on their own, demonstrating that social contact enhances mediated learning. His approach to child development is based on the idea that cognitive processes are the results of social interactions and the collaborative nature of learning (Adam, 2017). Powell, Cody, and Kalina (2009) justified that incorporating collaboration and social interaction will be highly effective for social constructivism and also beneficial to teaching and learning. On this account, Vygotsky explains the distinction between actual levels of development assessed on the basis of independent problem-solving and the higher level of potential development identified through the assistance of

collaboration with competent peers in the Zone of Proximal Development (ZPD), where the good learning takes place (Verenikina, 2010, as cited in Adam, 2017).

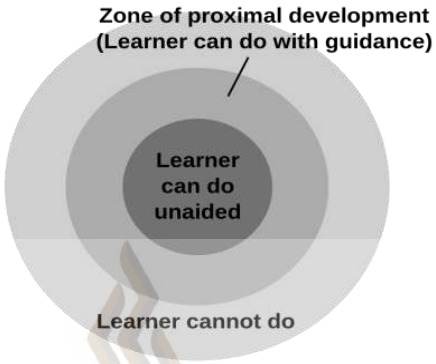

Figure 2.2 Illustrations on Zone of Proximal Development (ZPD)
Source: Wikipedia, 2012

Figure 2.2 on ZPD illustrates Vygotsky's theory (1987) in which the cognitive processes emerge initially at the social (inter- mental) level, and are subsequently absorbed and transformed into unique level of individual thinking (intra- mental level) (Fernandez, Wegerif, Mercer, & Drummond, 2015). Zulkarnaen (2019) also claims that learning that includes contact between students and teachers, as well as other students, has an impact on academic self-concept performance.

According to Isaacs (2013), collaboration enhances learning and it is a social process that leads to active and interactive learning. In addition he cited Smith and MacGregor's (1992), the following assumptions regarding collaborative learning: (a) learning is an active process; (b) learning facilitates students to process and synthesize knowledge; (c) learners gain from exposure to variety of views; (d) learning develops in a social setting; (e) learners must engage in discussion with peers, present and also defend ideas by exchanging varied opinions, and challenge conceptual frameworks. When students' knowledge is linked into a social setting, they can develop the knowledge more effectively. As a result, the connection between teacher and students improves when a bigger community of learners, that is, students working together is incorporated. To produce meaningful learning experiences, students should be

actively participating in the process of growing their understanding (Aydisheh & Gharibi, 2015). According to Jazim, Anwar, and Rahmawatia (2017), the use of a constructivism-based mathematics module by students while studying demonstrated that it was incredibly beneficial in improving students' mathematical comprehension. Furthermore, his observations performed throughout the learning activities demonstrated that while utilizing constructivism to study mathematics, students with high academic competence were more interested in the discussion process.

Baleni (2016) states that the use of internet, social media and mobile technologies are prevalent among the students, hence it considers the need for the teachers to explore the pedagogical approaches by integrating these technologies for academic purposes. With the change in terms of students' expectations and teaching methods, learning theories like collaborative learning are crucial to support the trend. Lew (2020) considers technological tools as a good way to assist students in developing their online social presence. It can be done using various online collaborative tools that encourage class discussions and allows document collaboration (Google Docs, Sheets, Slides, or Office 365). It can be believed that engaging learners through the designs and environments of technology can further inculcate experiences.

Therefore, the integration of web- applications and collaborative learning in a classroom context, demonstrates a strong relationship between technology and collaborative learning, indicating the implementation of each one benefits the other. It also ensures that the use of technology in the classroom by itself is not effective unless the teacher has a theory on which to base the instruction by significantly considering how the equipment is used rather than what equipment is used for teaching and learning.

2.7.2 COGNITIVE CONSTRUCTIVISM THEORY

Cognition is a generally termed as mental processes including attention, perception, comprehension, memory and problem solving. Piaget's cognitive

development theory explains how a child creates a mental representation of the world, believing it to be a process that occurs as a result of biological maturation and interaction with the environment. The children are like little scientists attempting to figure out what's going on around them thus, classroom learning should be student-centered and based on active discovery learning. Wells (2013) stated that technology based curriculum has the potential to promote design thinking, which can empower students discover problems and propose solutions for prospective technological advancements.

In a way this theory provides a fundamental framework for understanding age-related learning constraints and children's reasoning, which guides the teachers to create age-appropriate education, particularly at the pre-school and primary levels. It is also vital to be reminded that using lecture methods frequently and the rigorous memorization of information have been challenging for students to do well in the exam (Gyeltshen, 2018; Lhatu, 2017). The activities designed are the important component technological literacy, which the education should promote by improving design and creative thinking rather than restricting it. Thereby, the designed activities can also be part from early education especially when learning technological literacy (Lind, Pelger, & Jakibsson, 2020). As stated in the Scientific World (2019), the use of memory, motivation, and thinking are significant in the course of one's learning. As a result, the students preferably focus on education and interest in active participation, which drives their hypothesis selections, as well as the individual difference of learning styles and other alternative techniques.

According to Drakpa, Chaudhuri, Zangmo, and Yangchen (2021), one of the most important aims of education is the attainment of critical and higher-order thinking skills, with written examination being the prevalent approach of testing students' overall cognitive level. The questions are set by balancing between lower and higher-level questions following the framework of Bloom's taxonomy in the cognitive domain. The framework is organized in six levels: 1) remembering 2) understanding 3) applying 4) analyzing 5) evaluating and 6) creating. However, the students in the lower-level must know, memorize, repeat, and list information and the

higher levels must judge, criticize, resolve and make recommendations (Currell, 2021).

As a result, it is necessary to consider age-related factors while designing age-appropriate education using technology. This indicates that the teacher's awareness of the child's progress through the developmental process can benefit in understanding how the children learn. Further, it can guide the teachers in presenting mathematical concepts in a way that students can understand rather than delivering direct instruction. According to McLeod (2018), the teacher's responsibility is to promote learning, which may be accomplished in the classroom by promoting the following:

1) Concentrate on the process of learning rather than the ultimate result.

2) Applying active approaches that require the reconstruction or rediscovering of "truths."

3) Using both collaborative and individual activities (so students can learn from each other).

4) Creating a situation which provides useful issues while also causing disequilibrium in the youngster.

5) Find out the child's developmental stage so that the right activities can be given.

As pointed out by the researchers, while adopting web-based learning, self-efficacy and collective efficacy have a considerable influence on students' learning abilities, including greater feedback and learning approaches. Furthermore, learning strategies, group discussions, and group interactions help students do better academically. Highly motivated students use superior learning strategies and respond properly to environmental demands, such as using feedback to enhance performance in a web-based learning environment. Thus, knowing the child's growth through the developmental process can help teachers comprehend students' learning and, eventually, help teachers teach mathematical concepts in a way that students will be able to learn.

2.8 RELATED RESEARCH

According to Dragomir (2015), we live in a world where technology is rapidly evolving and a variety of programming is being introduced, implying the growing demands for programmers and as stated by Belmonte (n.d.), the new competencies and skills required in the digital age and knowledge-based society necessitate continuous changes in the educational process. Web-based teaching and learning approaches are recognized as important tools in the context of collaborative learning, because: 1) students assist their team in mastering collaborative assignments and achieving learning goals; 2) they assist each other in understanding the potential of collaborative learning thereby also inculcating core competencies with the help from peers; and 3) engaging the students to do the work together especially in challenging tasks, can assist in the acquisition of more knowledge (Gan, Menkhoff, & Smith, 2015).

According to Dimitrijevi (2012), teaching should be encouraged with the use of newly developed digital tools, and specifically, teaching mathematics using technology is best when technology is included in the education curriculum of teachers. Simultaneously, the students who view the computer tools positively are the ones able to overcome their initial challenges in using them leading to developing more productive behaviors. For further effectiveness of the digital tool, the study carried out by Ali (n.d.) explains the importance of using the internet in teaching and learning as a reliable source for educational tools whereby the teaching and learning using web applications can provide the interactive nature for educating, thus enriching the thinking and leading them to a more positive and encouraging attitude towards learning.

Calder and Campbell (2016) conducted a study in which they found out that students can use applications to interact and collaborate meaningfully with mathematical concepts while obtaining instant feedback on their participation. They can also connect and change various types of data or information. Mathematical ideas and procedures are mostly presented through web applications, which provide visual

and interactive learning environments. Furthermore, Carr (2012) in a study of fifth-grade students learning mathematics had discovered the use of applications enhanced students' engagement, practice, and reinforcement of concepts, which appeared to promote higher-order thinking and conceptual knowledge. According to Lin and Jou (2013), in the web-based learning environment, students had deeper conversations and insights in each learning activity (before as well as after class), which efficiently and successfully guided student learning levels and perspectives and particularly for more introverted students.

According to Star et al. (2014), technology-based instructional experiences help students stay motivated in maths and science. In terms of self-efficacy, engaging students with new technologies in academic contexts can be effective in Science, Technology, Engineering and Maths (STEM). Yadav (2017) stated that students are purposely grouped in the maths classrooms to create a range of ability levels, which allows them to be more attentive to group members' needs, encouraging them to sync with one another. The collaborative learning technique stimulates students to learn more and helps them understand and do better on accomplishing exams than using the traditional teaching-learning method. In addition, Eyyam and Yaratan (2014) stated that students' responses indicated a positive perception of the use of educational technology in class and continuing it would influence their attitude towards the educational technology. Further analysis on the mean results of the students' performance also revealed that the using educational technology had a positive effect on the performance of the students, which can be seen in their progress results. In addition, if technology is merged with collaboration, it will be very beneficial, as it is equally important in globalization. As stated by Kolesov (2019), globalization and Collaboration are interrelated since globalization considers no boundary and embraces other cultures; collaboration is concerned with interaction, which is essential for a healthy exchange. Therefore it is interaction in collaboration that leads to globalization.

Qing and Li (2011) stated that students learn through networks in web-based collaborative learning, which differs from conventional collaborative learning in terms of spatial flexibility, time and speed of working environment and focusing on

web applications or computer systems. In addition, this learning technique enhances students' cognitive activity and their ability in solving problems. As mentioned in the Theories of Cognition in Web- based Collaborative Learning System (2019), web-based collaborative learning is appropriate for all grade levels and class sizes. It is considered effective in stimulating students' participation in education, improving their performance by providing many possible opportunities for discussion and consensus, which boost the student's creativity.

Thus, based on the claims of several researches, the integration of web applications and collaborative learning to improve student's learning achievement and satisfaction was deemed for its effectiveness. To summarize, incorporating web applications and collaborative learning has undoubtedly a significant influence on students' learning achievement and satisfaction, indicating as an effective learning technique for students.

2.9 CONCLUSION

Mathematics is a part of everyday life and a very important discipline, considered as a core subject in the school system. Today, mathematics knowledge can be learnt through various applications or from various sites using the internet or by seeking help from others despite the distance. It shows that the responsibility for teachers is not just to teach but to help in facilitating or guiding the children as they progress with learning. And although there are abundant factors that reveal the poor performance of the subject, likewise many factors are also available that are responsible for the success of teaching and learning in mathematics. One such factor can be the teacher, who teaches flawlessly, being resilient with the pedagogies and incorporating technology too. On this account, teachers need to be updated with the various tools of teaching to meet interest in students' learning because the learning outcomes are significantly impacted by the types of teaching strategies/methods used by teachers.

Additionally, it is the curriculum that need not be left out because it is the guide that supports teachers and students to remain on track and fulfill the required outcomes. It has to be updated with time and in accordance with the changing global demands. The designers of the curriculum must collect the data from all the concerned stakeholders including teachers, students and parents as a community and further analyze to have a perfect curriculum for the upbringing of better citizens and better environment.

The studies carried out by various researchers have further indicated that the technology is an essential tool for effective teaching of mathematics. The use of technology not only brings better outcomes but also instills positive learning contentment of the students. Specifically, the technology applications support the environment of the contemporary world making each individual adapt and prepare for a better future. The various educational applications are recommended due to more learning happening in the process. The use of applications makes students interact and get well engaged, which is even difficult despite being together onsite sometimes. The important thinking skills like creativity and problem solving are also ignited in the students through the use of the various applications used by the teachers and students in the process of teaching and learning.

Furthermore, learning theories like social constructivism and motivational theory also supports the use of technology applications in teaching mathematics. This is because the use of technology motivates them in constructing their ability and improving their thinking skills. They are motivated when they are engaged and interact during the process of collaborative learning. As mentioned by Doak (2011), technology integration has been shown to assist in the creation of more authentic learning environments in which students are more motivated to attend, have more opportunities for communication and collaboration, and have more opportunities to apply higher order thinking and problem solving abilities to real-world applications.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter covers the overall methodology for doing the research. It outlines the study's population, samples, and subjects, as well as the demographic profile of the participants, the data collection instruments used, as well as their validity and reliability. This chapter also includes the methods for gathering data as well as the statistics used to analyze the data.

3.1 RESEARCH DESIGN

The researcher adopted a mixed methodology embedded with experimental design, which included both qualitative and quantitative approaches. It was used to examine the learning achievement of grade five Bhutanese students' and perceptions on using web- applications integrated with collaborative learning of Mathematics. According to Sahin and Ozturk (2019), the mixed research method, which integrates quantitative and qualitative research approaches, is used to investigate gaps in the literature that cannot be answered by a single method. The basic principle of mixed-method research is that rather than using a single method, the combination of quantitative and qualitative approaches will provide a better understanding of the research problem (Creswell, 2012). Cameron and Sankaran (2015), further defined mixed methods research as a study that involves gathering, evaluating, and interpreting quantitative and qualitative data in one or more studies that look at the same underlying phenomenon.

The pretest-posttest approach was utilized to gather the quantitative data from the sample group before and after the use of web- application and collaborative learning in order to measure the students' learning achievement. Semi-structured interview was also conducted as a part of the study to measure the contentment of

students. It was done once the intervention had been implemented. The research process of the sample group is depicted in Figure 3.1.

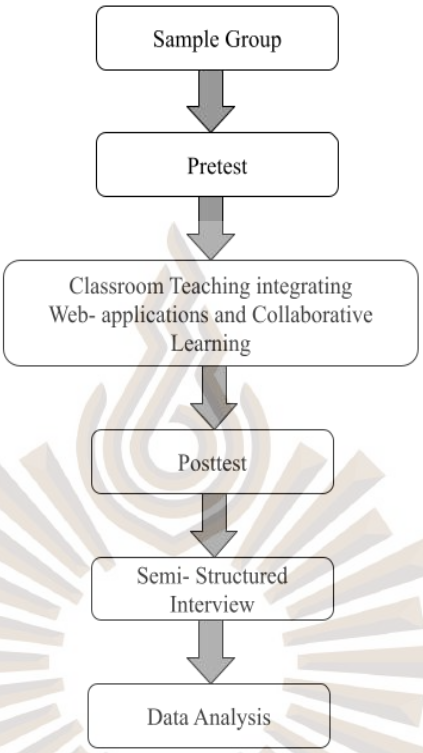

Figure 3.1 The Research Design

Figure 3.1 illustrated above shows the detailed research design. In the study, the sample group consists of 31 students of grade five. They were taught mathematics integrated with the web-applications and collaborative learning as a learning methodology. Before being engaged with the approach, the sample group was given to complete a pretest, and then the researcher implemented the integrated web-applications and collaborative learning in the teaching of mathematics for four weeks. The posttest containing the same questions were again given after the completion of intervention.

Following the completion of the post-test, the sample group participants participated in face-to-face interviews with the researcher to gather the perception in learning of mathematics integrated with web- applications and collaborative learning.

After that, the information gathered from the learning achievement assessments and semi- structured interview questions were examined and analyzed.

3.2 LOCATION OF THE STUDY

This research was conducted in a Bhutanese Lower Secondary School in Phuentsholing Thromde. It is located in the Southern foothills of Bhutan.

Figure 3.2 Location of the Study *(*Map of Bhutan)

Source: Google (Image)

3.3 POPULATION AND SAMPLE OF THE STUDY

3.3.1 POPULATION

The research was focused on grade five Bhutanese students who were studying mathematics in one of the schools in Bhutan. It is a Lower Secondary School located in the southern foothills of Bhutan under Chhukha district. For the academic year 2022, there were four sections of grade five: A, B, C, and D, consisting of 111 students of mixed ability. They were all of age ranging between 10- 12 years old.

3.3.2 SAMPLE GROUP/ RESEARCH PARTICIPANTS

The school consisted of four sections of grade five students, but because this was a one-group mixed-method study, the researcher used a cluster random sampling method and chose only one section. Hayes (2019) claims that clustered random sampling is a sampling approach in which researchers divide the population into groups and then select a random sample from each group. The significance of the cluster random sampling method is that it gives all groups an equal chance of being chosen. As a result, the researcher executed a lucky dip to avoid the bias of selecting a sample group. The study's target group consisted of 31 Bhutanese students in grade five. The sample participants' detailed information is shown in Table 3.3.

Table 3.1 Demographic Profile of the Research Participants

Item	Male	Female	Total
No. of Participants	12	19	31
Percentage	38.7%	61.3%	100%
Age Group	10 to 12 years old		

Table 3.1 illustrates the gender and age groups of the sample participants. 12 (38.7%) of the 31 students in the sample group were male, while 19 (61.3%) were female. The classroom had more females than males but had a relatively similar number of students in each age group, ranging from 10 to 12 years old.

3.4 RESEARCH INSTRUMENTS

A research instrument is a tool that is used to collect, measure, and evaluate data. It aids the researcher in gathering relevant and reliable data during the data collection procedure. For this study, the researcher used three instruments to collect data. These tools guided the researcher in teaching mathematics to the students, which were integrated with web-applications and collaborative learning. The instruments

included lesson plans, learning achievement tests (pretest and posttest) and the semi-structured interview.

3.4.1 INSTRUMENT OF THE INTERVENTION

3.4.1.1 Lesson Plans

The researcher had prepared four lesson plans of 90 minutes each integrated with web- application and collaborative learning to teach the chapter of 'Decimal Computation' in mathematics. There were four sub-topics in this chapter. The researcher had eight sessions and taught twice a week. The duration of the study lasted for four weeks. To teach the research participants, all of the lessons were taught by integrating the web- applications (Google slide with slido) and collaborative learning (refer Appendix C). Table 3.2 shows the time frame of teaching and learning the topic "Decimal Computation".

Table 3.2 Framework for Content of the lesson

Time	Topic (Decimal Computation)	Activity
Week I	Exploring Decimal Number (Thousandths)	i) Used Google slide for lesson as well as to do collaborative activity, ii) participated in slido to respond to the related questioning activity.
Week II	Adding and Subtracting Decimals	
Week III	Adding Decimal Thousandths	
Week IV	Subtracting Decimal Thousandths	

3.4.2 QUANTITATIVE DATA COLLECTION INSTRUMENT

3.4.2.1 Pretest and Posttest

A learning achievement test was administered to assess and compare the students learning outcomes before and after the intervention. Both pretest and posttest were included. Pretest-posttest designs are the preferred method to compare participant groups and measure their degree of change occurring as a result of treatments or interventions. Pretest was conducted before the introduction and implementation of the intervention, while posttest was done after the intervention had

been implemented. Both the tests were conducted on the same group of students providing the same questions as in the pretest. In Bhutan, the learning achievement test is based on learning outcomes and the questions are framed based on the mandates of Bhutanese education framework outlined by Royal Education Council (REC) and Bhutan Council of School Examination (BCSE), which follows Bloom's Taxonomy. It consists of six levels: (1) remembering, (2) understanding, (3) applying, (4) analyzing, (5) evaluating, and (6) creating. Hence following the mandates the achievement test for learning was prepared for 20 marks containing 10 marks of multiple choice questions, 5 marks for true or false questions, and 5 marks for short answer questions (refer Appendix E).

3.4.3 QUALITATIVE INSTRUMENT

3.4.3.1 Semi-structured Interview

According to George (2022), semi-structured interviews are an excellent method for researching qualitative data that can be interpreted as open-ended. Participants' thoughts, feelings, and beliefs concerning a certain topic can be gathered and explored more deeply. Thus, the researcher framed five questions, which were interviewed in a group of six after the intervention and then assessed the students' contentment in learning mathematics through use of web- applications and collaborative learning (refer Appendix G). The questions were selected based on themes and were primarily used to gather information and study about the students' perception. Therefore, the questions were categorized based on the following themes:

(1) Past experiences

(2) Enjoyment in learning mathematics integrated with web-applications and collaborative learning

(3) Sense of achievement in the learning of concepts

(4) Learning experiences with the interventions and

(5) Interest and motivation for learning.

Students were given approximately 10 minutes to respond and they also had an option of responding either in English or Dzongkha (the national language of Bhutan).

During the interview, students' statements were audio recorded so that they may be translated and transcribed later by the researcher. The data was then analyzed using a process called thematic analysis. Thematic analysis is a strategy for recognizing, analyzing, organizing, interpreting, and reporting themes in a set of data, as well as a translator for researchers which enables them to communicate with researchers using other methods (Nowell, Norris, White, & Moules, 2017).

3.5 VALIDITY AND RELIABILITY OF THE RESEARCH INSTRUMENTS

3.5.1 VALIDITY

Validity refers to how well the data gathered corresponds to the study's subject and according to Taherdoost (2016, p.28), validity is measuring what is supposed to be measured. It is an effective tool used for collecting data providing only valid information. Zohrabi (2013, as cited in Edwin, 2019), explains that validity is a way to clarify the truth of research findings. Three experts, including a professor from Rangsit University in Thailand and two experienced Mathematics teachers from Bhutan, validated the research instruments (lesson plans, achievement level test, and semi-structured interview questions). Item Objective Congruence (IOC) was used to determine the instrument's validity, which helped to determine whether or not the items are aligned with the learning objectives. The IOC index's result varies from -1 to +1, as mentioned below:

1) If the rating is 1, the item clearly meets the given objectives.
2) 0 means the item is uncertain or unsure if it matches the objectives or not.
3) -1 tells that the item is clearly unrelated to the objective.

The IOC was calculated using the formula: IOC = rn, where 'r' represents the score of individual expert ratings and 'n' represents the number of experts. The accuracy and acceptability of the test item were determined by its value between 0.67

and 1.00, whilst a number below 0.67 suggested that the item should be rewritten based on the expert's ideas and feedback.

All the instruments for this study were validated by the three experts and they were all rated +1, which indicated that the items were valid for the study. The rated IOC for lesson plans, learning achievement test questions and semi- structured interview questions can be seen in the Appendix D, Appendix F and Appendix D respectively.

3.5.2 RELIABILITY

According to Mohajen (2017), reliability concerns the faith that one can have in the data obtained from the use of an instrument. This indicates the degree to which any measuring tool is capable of producing consistent results from one test to the next, which in fact can assess the quality of the measurement procedure used to collect data in research. For example, a scale or test is said to be reliable if repeat measurement made by it under constant conditions will give the same result (Taherdoost, 2018, p.33).

A pilot test was administered to one section of grade 6 in the same school of research selected randomly by the school administration. The class consisted of 31 students and the questions were the same as the learning achievement learning test questions of grade 5 students, which consisted of 20 marks questions (10 marks multiple choice, 5 marks true or false questions and 5 marks short answer questions) from the chapter 'Decimal Computation'. It was done prior to the experiment and the Kuder-Richardson formula (KR-20) was used to determine the learning achievement test's reliability coefficient. The KR-20 coefficient for the instruments must be equal to or greater than 0.70 to be considered reliable. For the pilot test conducted in grade 6, the coefficient obtained was 0.77 (see Appendix I for the Reliability Test Report). This indicated that the coefficient 0.77 for the instruments was greater than 0.70, which revealed that the test items were reliable.

3.6 DATA COLLECTION PROCEDURE

The following processes were carried out to ensure the smooth flow of the data collection method while conducting the study.

3.6.1 Ethical Considerations

3.6.1.1 Approval

The researcher sought the approval from Rangsit University's research and development institute in Thailand, followed by an approval from the Ministry of Education in Bhutan. The researcher also obtained a consent letter from Thromde Education Officer (TEO), Principal, Mathematics Head of Department, as well as the concerned subject teacher of the research school (See Appendix A). Since the research participants were minors, the parents of each study participant were informed to read and understand the consent letter content before signing it, reducing the risk of research participants' rights being violated throughout the study (See Appendix J). Therefore, all the necessary approvals were sought before the actual data collection began.

3.6.1.2 Anonymity of the Participants

For the sake of confidentiality, the researcher maintained the views and opinions of the research participants anonymous. To ensure confidentiality, the participants were identified by numbers: Std 1, Std 2, and so on. This was also informed to the research participants prior to the intervention. Regarding the recordings, it would be destroyed once the study was over.

3.7 DATA ANALYSIS

The data analysis was carried out based on following two categories:

1) Analyze test scores to examine the effect of using the web-application and collaborative learning achievements in learning mathematics

2) Thematic analysis of semi- structured interviews to examine and determine how the students perceive the integration of web- applications and collaborative learning in the learning of mathematics.

3.7.1 ANALYSIS FOR LEARNING ACHIEVEMENT

Pretest and posttest were conducted before and after the integrating web-applications and collaborative learning in mathematics, which determined the level of students' learning achievement. Paired sample T-Test was used to analyze the learning achievement scores from the pretest and posttest by using suitable computer software. The research was further analyzed by comparing the mean, standard deviation, and significant value.

3.7.2 ANALYSIS FOR SEMI-STRUCTURED INTERVIEW

The researcher conducted a semi-structured interview with the participants to obtain a greater understanding of their perspectives on the integration of web-applications and collaborative learning in mathematics. The data collected through the semi- structured interview was analyzed with the developed themes and patterns through coding using thematic analysis technique. This analysis helped to examine the perception of participants towards learning of Decimal Computation in mathematics with peer review process for data analysis of integrating web-applications and collaborative learning.

CHAPTER 4

RESULT AND DATA ANALYSIS

This chapter presents the findings and the result analysis of the research topic 'The Integration of Web- Applications and Collaborative Learning in Mathematics for Grade Five Bhutanese Students'. The data analysis was done in two parts, with the researcher initially collecting the data through Pretest and Posttest fulfilling the Research Question One. Second, the data collected through the Semi- structured Interview was examined through thematic analysis of which the findings were used to respond to the Research Question Two.

4.1 QUANTITATIVE DATA ANALYSIS

Quantitative data were collected through pretest and posttest to assess the learning achievement level of students following the integration of learning interventions in mathematics. The pretest and posttest consisted of 14 distinct questions with 5 multiple choice questions, 5 true/false questions and 4 short answer questions, which were administered to 31 Bhutanese students of grade five before and after the intervention in mathematics.

The paired sample t- test was used to evaluate the sample group's pretest and posttest scores and then to determine the effectiveness of integrating web-applications and collaborative learning in the classroom of mathematics education. A comparative statistical analysis of the pretest and posttest scores was also made using mean, standard deviation, and significant value (P-Value).

4.1.1 DATA ANALYSIS OF STUDENTS' LEARNING ACHIEVEMENT TEST

The data collected from the pretest and posttest scores were analyzed to compare the learning achievements of the grade five Bhutanese students before and after the treatment as described in Table 4.1.

Table 4.1 Score difference between Pretest and Posttest.

STUDENT NO.	PRETEST	POSTTEST	IMPROVEMENT SCORE
Std. 1	7.00	14.00	7.00
Std. 2	11.00	14.25	3.25
Std. 3	8.25	15.00	6.75
Std. 4	17.00	19.00	2.00
Std. 5	15.00	18.50	3.50
Std. 6	5.00	18.00	13.00
Std. 7	10.00	12.25	2.25
Std. 8	9.00	12.25	3.25
Std. 9	8.00	13.00	5.00
Std. 10	14.25	18.50	4.25
Std. 11	4.00	12.00	8.00
Std. 12	9.00	18.50	9.50
Std. 13	8.00	12.00	4.00
Std. 14	6.00	9.00	3.00
Std. 15	9.75	11.75	2.00
Std. 16	11.25	16.00	4.75
Std. 17	9.00	12.50	3.50
Std. 18	11.25	15.00	3.75

Table 4.1 Score difference between Pretest and Posttest (Cont.).

STUDENT NO.	PRETEST	POSTTEST	IMPROVEMENT SCORE
Std. 19	12.00	18.00	6.00
Std. 20	7.00	8.00	1.00
Std. 21	11.00	15.00	4.00
Std. 22	13.00	17.00	4.00
Std. 23	9.50	13.00	3.50
Std. 24	7.25	11.75	4.50
Std. 25	12.00	16.00	4.00
Std. 26	11.75	14.00	2.25
Std. 27	11.50	19.00	7.50
Std. 28	8.25	13.00	4.75
Std. 29	8.00	13.00	5.00
Std. 30	6.50	9.25	2.75
Std. 31	15.00	19.25	4.25

Table 4.1 provides more details on students' increasing posttest scores compared to pretest scores. The lowest and highest pretest scores were 4 and 15.5, respectively, whereas the lowest and highest posttest scores were 8 and 19.25 respectively. Std. 6 improved the most, receiving 13 points more on the posttest than on the pretest, while Std. 20 improved the least, receiving 1 point more on the posttest than on the pretest. The student with the highest improvement score revealed that the treatment had a significant and positive impact on their learning, while the student with the lowest improvement score described how they were trying to cope up with the practice and the new learning intervention. However, as compared to the pretest, all student participants scored much higher, demonstrating a significant improvement

in students' mathematical ability after integrating web-applications with collaborative learning in mathematics.

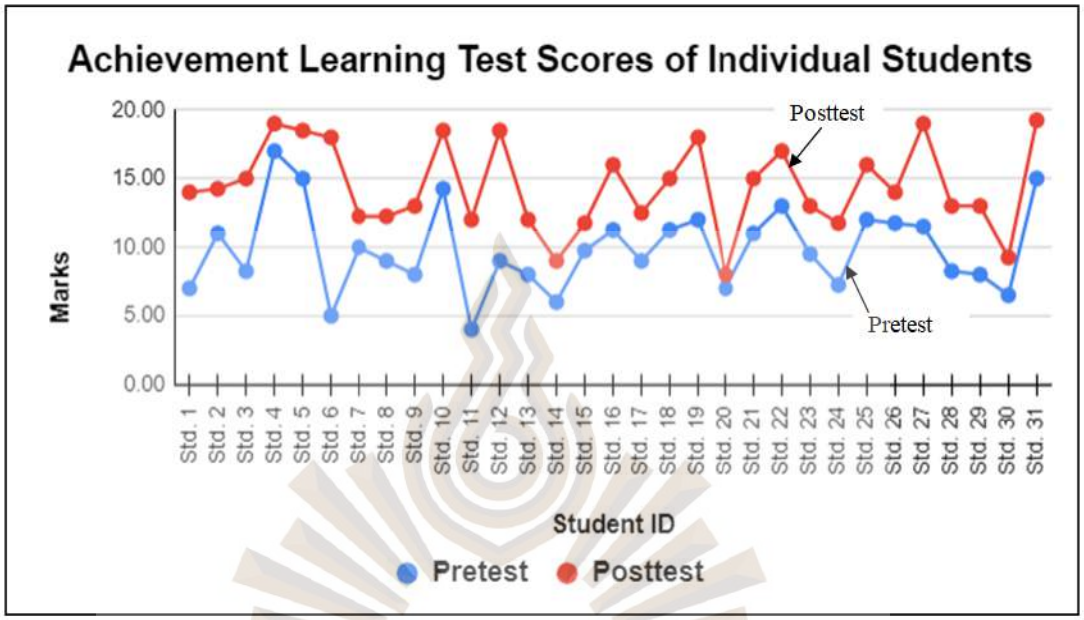

Figure 4.1 Comparative graphical representation of individual student learning achievement scores in Pretest – Posttest

In figure 4.1, the learning achievement scores of the individual students are represented by the blue line for pretest and red line for post test respectively. The red line in the graph representing the posttest scores of the students depicts that the students have performed better in mathematics after integrating the web- applications and collaborative learning.

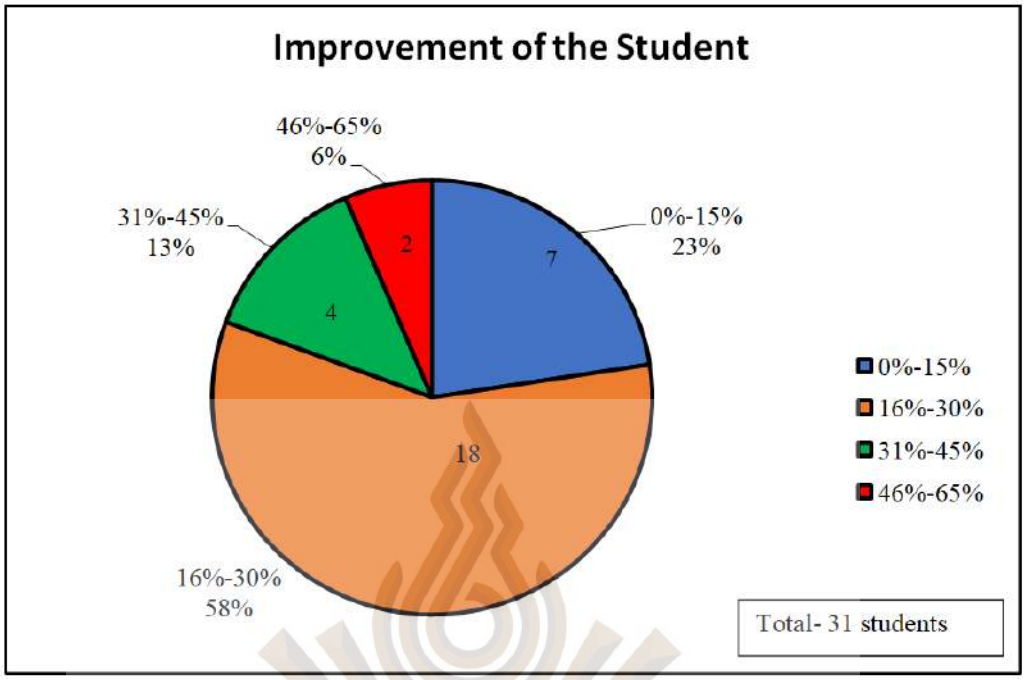

Figure 4.2 Number of students in each score difference

The pie chart, in figure 4.2 illustrates the number of students categorized under each score difference compared between the pretest and the posttest. According to the representation, there are 31 students from which 7 students equal to 23% secured 0-15% more in the posttest than in the pretest indicating the minimum increase of score in posttest compared to other students. On the other hand, 2 students equaling 6% of students improved the score by 46-65% in the posttest than in the pretest which shows maximum increase of score. Overall, the highest score after comparing the pretest and the posttest was 65% secured by 1 student and the lowest was 5% increase in the posttest secured by 1 student.

In addition, the collected data of pretest and posttest scores were also analyzed to show the result of the descriptive statistical analysis for the sample group's achievement test scores as presented in Table 4.2.

Table 4.2 Comparison between pretest and posttest within the sample group.

Group	Pretest		Posttest		Mean Difference	T	P – value
Sample Group	$\bar{x}$	SD	$\bar{x}$	SD	14.44 -10.24 = 4.2	-8.66	.01
	10.24	3.03	14.44	3.15			

Significance level (p): < 0.05- significant

In table 4.2, the pretest and the posttest had a mean score of 10.24 and 14.44 respectively. The data shown in table 4.2 clearly showed that the group's posttest mean score (x=14.44) was greater than its pretest mean score (x=10.24), with a mean difference of 4.20. Thus, the greater mean score in the posttest indicated the efficiency and effectiveness of integrating web- applications and collaborative learning. Table 4.2 also shows the standard deviations of the pretest and posttest with 3.04 and 3.15 respectively, followed by a paired sample t-test result, which revealed the significance of the test with a significance value of .01.

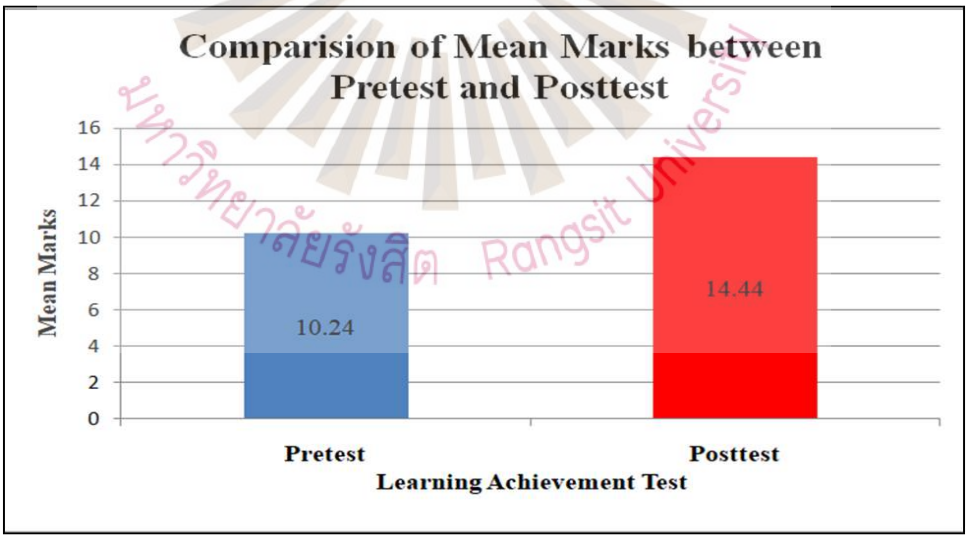

Figure 4.3 Pretest and Posttest Mean Comparison

According to the mean scores, the posttest showed a comparatively higher mean score than the pretest, which indicated that their learning achievement prior to using the intervention was lower compared to the learning achievement after using the

intervention. Furthermore, it is clearly shown in figure 4.1where the mean of the posttest is greater than that of the pretest. All these scores in comparison had confirmed the effectiveness of using web- applications and collaborative learning in enhancing the learning achievement of Grade 5 Bhutanese students in mathematics. Therefore, the finding was evident in providing a positive response to the first research question, which had ascertained the research objective one and the hypothesis one.

4.2 QUALITATIVE DATA ANALYSIS

Semi-structured interview was used to collect the qualitative data by focusing on to responding the second question of the study, which was to find out the students' perception towards web- applications (Google Slide and Slido) and collaborative learning in mathematics.

4.2.1 ANALYSIS OF SEMI-STRUCTURED INTERVIEW

The interview was conducted on the student participants at the end, after the intervention. Owing to time constraint and large number of students, the interview was administered in groups of 5 members. The groups were formed by providing numbers to the students from 1 to 6 randomly and they formed the group based on their numbers. It was informed prior to the intervention that the researcher will protect the privacy of the student by maintaining confidentiality. Considering this, the researcher named the semi- structured interview groups as Group 1, Group 2, Group 3 and so on. The student participants were also given the liberty to share their opinions in any language they felt comfortable, which was later transcribed by the researcher to English for further data analysis. The data was then analyzed using five themes: 1) Past Experiences 2) Enjoyment 3) Sense of Achievement in Learning Concepts 4) Learning Experiences with the intervention and 5) Interest and motivation for Learning. Listening through the responses of the students, the majority of the responses depicts positive opinions about the integrated interventions.

4.2.1.1 Past Experiences

According to the students, this intervention was a new kind of learning experience for them. They have been learning through some other strategies like the demonstration method activity based, use of chalk and chalkboard method and so on, which were mostly the onsite methods. Most of the lessons they had learnt were given to understand on their own after the teacher's explanation and the tasks were also given mostly to do independently, which lacked of no understanding for some students thereby ending up with incomplete task or copying from friends.

> "Our teacher mostly taught us using chalk and chalkboard, where he demonstrated with the examples for few times and then we were given to do the activity ourselves in the class or as homework." (Group 2)

> "We did use Google classroom but it was for submitting our works and to go through the announcements on individual tasks or project works and then also to read the comments of our submitted works". (Group 5)

> "We have learnt by doing our activity using cooperative method, which was not online and we had difficulty to catch up with the group later after the school hours since some of the members were living far from each other". (Group 6)

4.2.1.2 Enjoyment

The students enjoyed learning the mathematics lessons integrated with web- applications and collaborative learning. Students were actively taking part in the classroom and were also found enquiring on using it for the lessons by either asking to the researcher or to their friends. This indeed, allowed them to learn by connecting each other further leading to understanding of the lesson. The responses expressed by the student also indicated that they have enjoyed learning mathematics using web-applications and collaborative learning. According to the students:

"We enjoyed learning collaboratively in pairs and in groups with the members as we all got to learn by cooperating with each other". We also enjoyed participating without hesitation in responding to the question by joining in the Slido from our individual computer". (Group 1)

"We enjoyed the opportunity to digitally interact with our friends in doing the pair and group works. We are able to also do the edit and make necessary corrections online together". (Group 2)

"Since we already enjoy using IT, learning mathematics with web- application further added to our enjoyment in learning because there was much easier way to create and add the required images for further understanding of the lesson". (Group 4)

"It was fun creating hundred grids, place value chart in the Google slide and getting to learn how to share our Google slide with the group members was a new way of learning for us". (Group 5)

The opinions mentioned by the students revealed that the students enjoyed the lessons. This is because the use of these tools can help enhance the learning process. In addition to being able to provide a fun and engaging learning environment using Google slide, the use of collaborative learning techniques can also help improve the students' performance.

4.2.1.3 Sense of Achievement in Learning Concepts

During the interview, students shared on having a positive impact on learning mathematics concepts using web- applications and collaborative learning. Some of the statements that the participants provided are as follows:

"Using web application made it easier for us to interact with our friends and team members, thereby being able to help each other and we understand the concepts clearly too". (Group 1)

"The application helped us to do the given work faster and we got enough time to collaboratively go through all the content and do the necessary editing and correction". (Group 3)

"As we use the applications online, even if we have any doubts, we feel comfortable to ask our friend since we get use to learning together by helping each other in groups or in pairs". (Group 4)

"Since the teacher shares the note, we are able to browse from anywhere we like from our phone and revise ourselves. We find it easier because we carry mobile anywhere we go". (Group 5)

"The way we can use Google slide to do the work together, has made our work easier. We do not have to carry our notebooks regularly. Moreover, doing the assignments in the Google slide together with the members has made us learn better and faster". (Group 6)

The students with satisfaction have shared that the use of web-applications and the collaborative learning techniques have helped them gain a deeper understanding of the concepts they were learning. Nevertheless, improving the way of doing assignments and follow-up study online has motivated them to show interest in learning mathematics.

4.2.1.4 New Learning Experiences with the intervention

Integrating web- applications and collaborative learning in mathematics was a new way of learning for the students. Generally, they learnt mathematics using chalk and chalkboard with demonstration method and activity based method. But having said and getting to learn with this new intervention was a positive experience for them. They faced a bit of challenges but once they understood, it became a usual flow to their learning process. Following are some of the learning experiences share by the students:

"It seemed difficult at first but we got use to it and then our learning using it became simpler and easier. We were able to share our presentation with our friends and also helped each other in the learning process". (Group 1)

"When working together with the group members, we helped each other and learned to rename the Google slide, chat from the slide, and also change the themes of the slide". (Group 3)

"In the learning process, we were also able to screenshot the require parts of the pictures and paste in our assignment". Using the online marker, we were also able to show the correct methods of adding and subtracting the decimal numbers". (Group 4)

"When I was not able to find my Google slide work, my friends reminded me by helping to search through Google drive for the Assignment using the title of my Google slide". (Group 6)

Use of web- applications and collaborative learning have helped each other to learn new things on Google slide by exploring with their team members, which has helped in developing their sense of team spirit and interest in learning mathematics.

4.2.1.5 Interest and motivation for Learning

Integrating web- applications and collaborative learning in mathematics was a new intervention they got to experience and as they liked using computers, it further built a sense of interest and motivation for learning mathematics. The data collected through the group interview shows how attracted the students were towards learning mathematics using the new intervention that made them interested and motivated for learning.

"Learning with web- applications is interesting and fun to learn. It not only helped us to learn maths but it is also helpful for our ICT knowledge". (Group 1)

"We would also want to learn other topics through use of web- applications and collaborative learning because it doesn't restrict us to learn alone but learn together by sharing and assessing our work together. (Group 2)

"Using these web-applications can help us to learn and understand the lessons better because if we face any doubts on any of the slides or topic in the presentation slide, then we can directly contact and share the slide to our friends or teachers online. So, this method can make us love to study and understand the lesson better". (Group 3)

"Learning just by watching and listening alone is very difficult all the time but when we get to learn using web- applications and collaborative learning, we can explore our learning, which leads to better understanding. Moreover, it can be easier to seek help from friends." (Group 4)

Analyzing through the responses of the student participants, it can be understood that they loved learning mathematics using web- applications and collaborative learning. In addition, it can further be noted that the learning mathematics using these interventions have built their interest and they consider it to be exciting for learning other lessons as well. In conclusion, the researcher found that incorporating web-applications and collaborative learning in mathematics not just develop the level of learning achievement in students but also leads the students towards perceiving the mathematics subject positively,, which have a direct correlation to the development of students' overall academic performance.

CHAPTER 5

CONCLUSION, DISCUSSION, AND RECOMMENDATION

In this chapter, it presents the conclusion of the result of data analysis, the discussions on findings with the relevant literature and the recommendations that will help to enhance future studies to improve the learning process in general as well for teaching mathematics.

5.1 CONCLUSION

The study on the integration of web- applications and the collaborative learning in mathematics was done with the purpose, which was guided by two main questions:

1) Would the integration of web- applications and collaborative learning improve the learning achievement of grade five Bhutanese students in mathematics?

2) What was the perception of grade five Bhutanese students towards web- applications and collaborative learning in mathematics?

Quantitative and Qualitative data were collected in the form of learning achievement test scores (pre-test and post-test) and the semi-structured interview respectively. These were then analyzed to make further conclusions of the findings.

5.1.1 THE RESULT OF TEST SCORE ANALYSIS

The researcher used the pretest and posttest scores with purpose to find out the improvement level of grade five Bhutanese students' learning achievement for the topic decimal computation in mathematics. The pretest was conducted on the students

before the use of the web- applications (Google Slide & Slido) and collaborative learning and then the posttest with the same questions to the same students were conducted after the implementation of the interventions (See Appendix K for Learning Outcome of the Test).

Using the paired sample t-test, a comparative statistical analysis was conducted on the student participants to determine the difference in learning achievement between the pretest and the posttest. Significantly, the pretest and posttest mean scores were 10.242 and 14.444 respectively, which proved that their difference was 4.202. Hence, according to the findings of the study, the mean score of the posttest was greater than the mean score of the pretest, as it is indicated in Table 4.2 in Chapter 4. It also reveals that the significance value (p) was .01, showing that there was a statistically significant rise in the posttest scores of the research participants over the pretest scores.

Consequently, the study showed that integrating web-applications and collaborative learning in mathematics resulted in a significant improvement in the learning achievement of Bhutanese students in grade 5. Thus, this result proved the initial research hypothesis made about the improvement of learning achievement using web- applications and collaborative learning was true.

5.1.2 THE RESULT OF SEMI-STRUCTURED INTERVIEW

The researcher used the semi-structured interview to collect the information on the perception of students towards the use of web-applications and collaborative learning in mathematics. Since the perception of the students matters a lot in their academic performance, the students' learning must motivate and create high enthusiasm towards bringing positive and greater learning achievement. So, with the pursuit to respond to the second question of the research, the researcher did the semi-structured interview to compile the qualitative data from the student. The second question of this research was “What was the perception of grade five Bhutanese students towards web-applications and collaborative learning in mathematics?”

The researcher conducted semi-structured interviews with grade five Bhutanese students who participated in the study. Due to the time constraints of the approaching examination, the research participants were divided into six different groups by giving the freedom to create their own groups. The data collected from the students' responses were then analyzed using thematic analysis, resulting in satisfying responses about the web-applications and collaborative learning in decimal computations. The data collected from their semi-structured interview responses were reviewed by the researcher based on five themes: 1) Past Experiences 2) Enjoyment 3) Sense of Achievement in Learning Concepts 4) Learning Experiences with the intervention and 5) Interest and motivation for Learning.

After analyzing the students' responses, the data indicated that the students were enthusiastic as well as motivated to learn mathematics using web- applications and collaborative learning. Their interest in exploring and using technology has further boosted them to participate actively in learning mathematics using web-applications (Google Slide and Slido) and collaborative learning. The students have also learnt that using web- applications and collaborative learning have made their learning comfortable and easier to understand the lesson, which has encouraged them to learn other lessons too with these interventions.

In addition, the data also indicated that using web- applications and collaborative learning in mathematics has a positive impact on students' perceptions and their learning. As the use of this intervention enhances the learning of the students, there is no doubt that they will also be able to learn other lessons better. The data continues to show their desire to use the web- applications and collaborative learning in other subjects, so that they can be able to make their learning easier and better. More so, they consider that this intervention has made them able to do the group work on time without having to meet with their group member but do online by sharing the Google slides and help each other to understand the tasks and complete on time. They were happy to also learn that they can easily study the lesson shared by the teacher and do the work from anywhere online.

As a result, the qualitative instrument of semi-structured interview was successful in responding to the second question of the research. It has, in effect, given the students positive perceptions of using web-applications (Google slide and Slido) and collaborative learning in strengthening the learning achievement of grade five Bhutanese students in learning mathematics. It has also additionally made the students perceive the subject positively.

5.2 DISCUSSION

According to this research, the study focused on finding the data on two important questions, which were to assess the improvement in the students' learning achievement and to examine the perception of grade five Bhutanese students toward web-applications and collaborative learning. The findings of the study were: 1) the use of web-applications and collaborative learning was effective to improve the learning achievement of grade five Bhutanese students, and 2) the students had positive perceptions towards the use of web-applications and collaborative learning in mathematics. The findings are further discussed under two following headings:

1) Students' Learning Achievement
2) Students' Learning Perception

5.2.1 STUDENTS' LEARNING ACHIEVEMENT

The study using the web-applications and collaborative learning in mathematics to grade five Bhutanese students resulted in the improvement of their learning achievement. It was apparent from the learning achievement result of their pretest and posttest scores of the student participants, which reveals that the posttest mean scores ($\bar{x}$ 14.44) were significantly higher than the pretest mean scores ($\bar{x}$ 10.24) with a mean difference of 4.20. Incorporating the web- applications and collaborative learning shows that majority of the students have scored high in the posttest with the 2-tailed significant value of .01. Thus, the findings indicated that integrating web-

applications and collaborative learning was the effective approach in teaching mathematics to improve students' learning achievement.

Comparing the data of students' learning achievement, it was not just the performing students excelling but also showed the significant improvement in the performance of the struggling students. This finding is in line to McLeod (2018), where he stated that integrating the web- based learning had considerable influence on the students' learning abilities through learning strategies, group discussions and group interactions helping students to do better academically. Additionally, the study of Lin and Jou (2013) also supported that in web-based learning, students had deeper interactions and insights in each learning activity, which effectively guided the students' learning level and perspective especially for introverted students.

Moreover, there are also other studies supporting the fact that integrating web-applications and collaborating learning has a positive impact on academic achievement of the students. One such finding is the study of Star et al. (2014), which stated that engaging students with technology- based learning can be effective in academic context as it keeps students motivated in maths and science. Nevertheless, as per the Theories of Cognition in Web- based Collaborative Learning System (2019) have proven that web- based collaborative learning is appropriate for all grade levels and class sizes resulting in improved performance of the students. All these studies embrace the integration of web- applications and collaborative learning as an effective tool for students' learning achievement and satisfaction. The study aligns to the study conducted by Tsuei (2014). The finding revealed that primary school students have a higher rate of increase in maths aptitude scores, which was especially relevant to low achieving and low self-esteem students.

Furthermore, the improvement in posttest shown by the participating students was due to the collaborative skills that they inculcated by being able to communicate and interact with their peers for learning, which attributed the effectiveness of using web-applications and collaborative learning in mathematics. This was in relation to the study carried out by Gan et al. (2015). Their findings indicated that the web- based

teaching and learning approach had a positive impact on the students. It had assisted the students in mastering collaborative activities, instilling core skills, acquiring more knowledge and achieving the learning goals. Hence, this study had further proven the improvement of students with learning achievement in mathematics using web-applications and collaborative learning.

5.2.2 STUDENTS' LEARNING PERCEPTION

This was the second important finding of the study, where the data showed that the student participants had a positive perception towards the use of web-applications and collaborative learning in mathematics. Having taught the topic decimal computation in mathematics using web-applications and collaborative learning had made the student perceive learning as exciting and fun learning. It was found out that they were contented with the treatment used and it even motivated them to exhibit their interest toward learning mathematics. In fact, by learning using web- applications and collaborative learning, it was learnt that the students had realized that doing the activity in the Google slide has simplified their work since they could share the slide with anyone and they could also seek necessary help for better learning and achievement. Furthermore, it built a sense of confidence for their knowledge acquisition by working collaboratively with their peers and members.

The data collected from the interview also showed that the use of web-applications and collaborative learning made the complexity of the learning simpler to understand. This was in line with the study carried out by the Department of Professional and Curriculum Development (2022). In this finding, the students were able to comprehend the mathematical concepts by using visuals, simulations and representations as provided by ICT technology. They were also able to progress their learning at their own pace and communicate the ideas by communicating with friends as a part of the knowledge building process. And since learning mathematics requires a lot of thinking skills, the use of web-applications and collaborative learning has assisted the students to communicate their understanding of the concepts and progress on their learning. In parallel to this, Ali (n.d.) explains that the use of web-

applications can provide the interactive nature for education by enhancing the thinking level of the students and leading them to a more positive and encouraging mindset towards learning.

The result of the interview also presented more positive reviews about having an effective impact on learning mathematics with web-applications and collaborative learning. The review was in line with a study made by the Education Monitoring Division (2021), to investigate the effects of learning online during COVID- 19. This revealed that 74.48% of student respondents enjoyed and appreciated the effectiveness of being engaged in learning online. The statement was also supported by the study carried out by Calder and Campbell (2016). Their findings indicated that students were able to use applications to interact and collaborate meaningfully with mathematical concepts while receiving quick feedback on their participation, which helped them perceive the learning positively leading to improved learning achievement.

Similarly, the use of web- applications and collaborative learning also helped students to be actively involved in the learning process leading to better understanding of the lesson and improved retention power. Aydisheh and Gharibi (2015) has found out that students experience a meaningful understanding when they are linked to a social setting and actively participate in the process of their growing understanding. The use of web- applications and collaborative learning has assisted students in working collaboratively to get exposed to diverse viewpoints and defend their ideas inculcating active engagement (Smith & MacGregor, 1992). As stated in the Scientific World (2019), the use of memory, motivation and thinking plays an important role in the process of an individual's learning. In addition, the use of web-applications and collaborative learning helped students to stay focused through engagement in active learning leading to better understanding.

All the positive findings about the integration of web-applications and collaborative learning in mathematics were attributable to students being given the opportunity to easily explore and learn with the technology. Nevertheless, possessing

these technical skills made their learning environment favorable to learn collaboratively, promoting better understanding and success. It was because learning mathematics with web-applications and collaborative learning methods simplified their learning by allowing the students to seek help from teachers and friends from anywhere, resulting in getting immediate feedback and support. Hence, it can be concluded that web-applications with collaborative learning can be effective for grade five Bhutanese students in learning mathematics.

5.3 RECOMMENDATIONS

Depending on the findings from the study, it was concluded that integrating web- applications and collaborative learning was effective and successful in the teaching and learning of mathematics. As a result, considering the treatments to be impactful in teaching and learning, the following recommendations are made that could be implemented as well as it can be valuable for the future researchers.

5.3.1 RECOMMENDATION FOR PRACTICE

1) The teaching of mathematics for the topic Decimal Computation has been a successful, as shown by the improvement in students' performance. The learning achievement test scores of the students, where the posttest is significantly higher than pretest score, clearly depict the effectiveness of this intervention.

2) The integration of web-applications and collaborative learning is not restricted to mathematics only but can be also applicable in any other subjects like English, Dzongkha, Social Studies, Science and ICT. This is because the web-application used is Google slide, which is an online PowerPoint presentation slide that can be used for preparing and presenting the lessons for any online lessons as well as for onsite class.

3) Using web-applications, the teachers can make the class engaging, interactive and interesting, since Google slides can be shared individually to the student, which they can use it for reference and given the work, they can also do the work collaboratively. It also allows chatting from the same slide as well as can be used for responding to the questions through Slido, where their responses can pop- up in an instant they submit.

4) The web-applications can also be used for providing individual or collaborative tasks. The creator can share the slide through email or send the link through any other social media application. Even teachers can have the students do the work in the same presentation but on a different slide, which can help them monitor and assess everyone's work easily online.

5) Integrating web- application and collaborative learning in mathematics can further let students rationalize mathematics as an interesting subject since the online connectivity provided through Google slide enables them to seek necessary help and provide instant feedback and guidance.

5.3.2 RECOMMENDATION FOR FUTURE STUDY

1) The study was done to grade five Bhutanese students and for mathematics only but it can be applicable for different grade levels as well as for other subjects.

2) The duration of evaluating the approach can be extended to more than a month, to strengthen the findings of the study.

3) The study was done to only one grade considered as an experimental group. However, the result could be also rationalized by having a controlled group and an experimental group, whereby the researcher can use the traditional method on controlled and the new intervention on the experimental group.

4) The study was confined to the use of only two types of web-applications (Google Slide and Slido). However, there are various other web-applications, which can be explored for more impactful teaching and learning.

5) This research was conducted on a primary level but the future researcher can consider on doing this study at a higher grade level as well to assess the success of the approach.

To conclude, the integration of web-applications and collaborative learning in mathematics has proven to be an effective tool and strategy, which can change the mindset of the students positively and enhance the teaching and learning in mathematics. Since, students were regularly kept engaged and were given to interact a lot, it was noticed that they enjoyed learning and understood the concepts better. Moreover, it was indicated with their learning achievement results. Therefore, it can be summarized that integrating web- applications and collaborative learning in mathematics can improve the learning achievement of the students and make the students perceive the subject positively.

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APPENDICES

APPENDIX A
LETTER OF APPROVAL

RSU มหาวิทยาลัยรังสิต RANGSIT UNIVERSITY

มหาวิทยาลัยรังสิต เมืองเอก ต.หลักหก อ.เมืองปทุมธานี 12000
Rangsit University Muang-Ake, Paholyothin Rd. Pathumthani 12000, Thailand
T. (66) 2997 2200-30 F. (66) 2791 5753 E. info@rsu.ac.th

Director General
Department of School Education
Ministry of Education
Thimphu, Bhutan

Date: July 8, 2022

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

Dear Sir,

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 theses in Bhutan in the period of July 10, 2022 to August 20, 2022. The details of the candidates are shown as follows:

Sl. No	Name	Research Title	Research School
1	Tenzin Pema	The Application of Intensive Reading Approach with video for ELS Reading Comprehension Skill of Grade 6 Bhutanese Students.	Chumithang Middle Secondary School, Chhukha.
2	Leki Dorji D	The Application of Place-Based Education in Social Studies of Grade 5 Bhutanese Students.	Jyenkhana Primary School, Haa.
3	Pema Seldon	The Integration of Web Applications and Collaborative Learning in Mathematics for Grade 5 Bhutanese Students.	Phuentsholing Lower Secondary School, Phunentsholing Thromde.
4	Tshering Pem	The Application of Play-Based Learning for a Science Subject of Grade 5 Bhutanese Students.	Dechencholing Higher Secondary School, Thimphu Thromde.
5	Pema Dorji	The Study of Primary Bhutanese Teachers' Perceptions and Practices Towards the Use of Technology in Teaching.	13 Primary Schools, Tsirang.

Thank you for your kind consideration.

Truly yours,

NIPAPORN S

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

Mobile Number: +66-868846226
Telephone: +662997-2222 ext.1275

Chief, SPCD
For review & n.a.
4/7/22

དཔལ་ལྡན་འབྲུག་གཞུང་། ཤེས་རིག་ལྷན་ཁག།

Royal Government of Bhutan
Ministry of Education
Department of School Education

Rethinking Education

ཤེས་རིག

DSE/SPCD/SLCU(2.1)2022/1538

July 4, 2022

Chief Dzongkhag/Thromde Education Officers
Chukha, Haa and Tsirang Dzongkhag
Phuentsholing and Thimphu Thromde

Subject: Approval to collect data for Master of Education Thesis.

Dear Sirs/Madams,

The Director, Master of Education Program in Curriculum and Instruction at Suryadhep Teachers College, Rangsit University in Thailand has written to the Ministry seeking permission to conduct data collection from the attached list schools for thesis writing of our teachers who are undergoing their Masters Degree at Rangsit University.

To this effect, the Ministry of Education is pleased to accord approval for collection of data as per the list from the month of July to August, 2022. However, the researchers are requested to carry out the task without affecting the normal instructional hours.

Therefore, you are requested to kindly facilitate the researchers to collect data for their theses please.

Thanking you,

Sincerely yours,

(Karma Galay)
Officiating Secretary

Copy to:

1. Principals of the listed schools for kind information and support
2. Director, Master of Education Program in Curriculum and Instruction, Suryadhep Teachers College, Rangsit University for kind information
3. Chief Program Officer, SPCD, DSE for kind information

Post Box No. 112, Kawajangsa, Thimphu, Bhutan, Tel: PA: +975 2 325325, www.education.gov.bt

Principal

Phuentsholing Lower Secondary School

Phuentsholing Thromde

Date: July 12, 2022

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

Dear Sir,

I am currently pursuing my Master of Education in Curriculum and Instructions at Rangsit University. As per the requirement of my study, I am conducting my research on "The Integration of Web Applications and Collaborative Learning in Mathematics of Grade Five Bhutanese Students". This research study necessitates the teaching of Mathematics lesson with student involvement and the instruments for the study comprises of the pretest, posttest, and semi- structured interview to collect the required data.

Therefore, I would like to seek your permission to collect the data for my thesis from your school w.e.f July 19th, 2022 to the mid of August. Regarding the name and identification of the school and students will be recorded as confidential. Looking forward for your great support.

Thanking You

Yours Sincerely

Pema Seldon
Student
Rangsit University
Thailand.

PRINCIPAL
Phuentsholing Lower Secondary School
Chukha Dzongkhag

VICE PRINCIPAL
Phuentsholing Lower Secondary School
Thromde
Academic Head.

Subject teacher

APPENDIX B

EXPERTS WHO VALIDATED THE RESEARCH INSTRUMENT

Details of three expertise who validated the instruments

Three Experts are:

Sl. No	Name	Qualification/ Position Title	Institute
1	Dr. Gary Torremucha	Associate Professor	Rangsit English Language Institude (RELI); Rangsit University
2	Mrs. Tshewang Lhamo	M.Ed/ B.Ed English Teacher	Taju Primary School, Paro
3	Mr. Rigzin	M.Ed/ B. Ed Maths Teacher	Khangrab Primary School, Bumthang

Instruments

1) Four Lesson Plans
2) Learning Achievement Test
3) Opinion Questionnaire
4) Semi-Interview Questions

APPENDIX C

LESSON PLAN

Lesson Plan No: 1

Class: V **Subject: Mathematics**

Topic: Decimal Thousandths

Time: 90 Mins

Teaching Learning Material: Projector and Computer Desktop

Lesson Objective (s): By the end of the lesson, each student will be able to:

- Use the Decimal Place Value Chart
- Identify Decimal Thousandths
- Represent Decimal Thousandths on the Thousandths Grid.

Lesson Introduction (15 mins)

- Exchange greetings with the class and have the students seated comfortably.
- Tell the student to open the slide shared to them and as well as present it using the projector. Followed by asking the following question. Let them answer using slido.
    1. What do you understand by Decimal number?
    2. Where in a number, is the decimal point marked?
    3. (show a decimal number) Identify the decimal place value of each digit in the decimal number.
- Show the Title, "Decimal Thousandths".

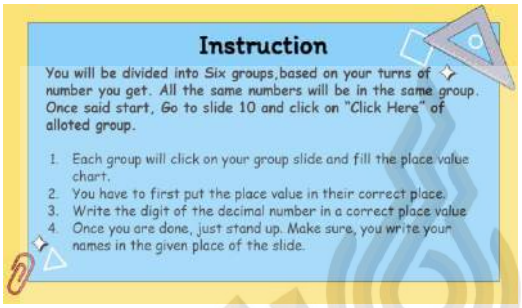
Lesson Development/ Activities (45 mins)

- **10 mins**
- Using a place value chart, the teacher will demonstrate decimal points on the place value chart and the Thousandths place.

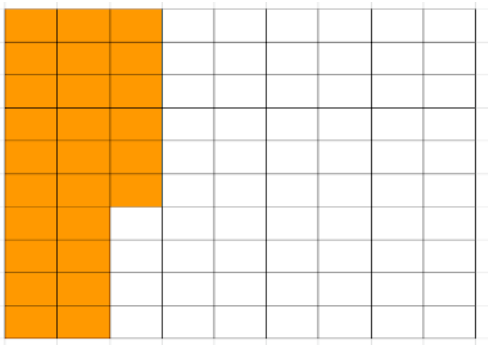
- Followed by showing a decimal number and asking where to put each digit in the value chart. Likewise show some more examples.

Activity 1 (15 mins)

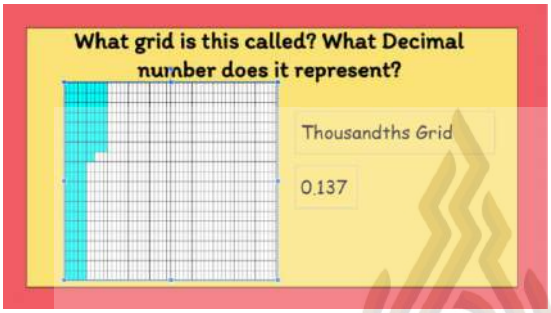
- Divide the students in groups of six by having them tell the number 1 to 6 and tell them that the number they got is a number of their group. Explain to them the instructions and give them to do the work collaboratively.

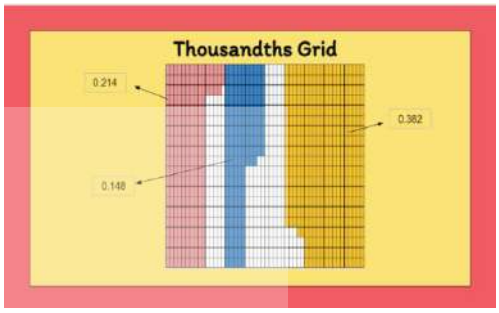


- Monitor and guide the students and in case they require assistance, help them.
- After all the students have completed the given task, present the slide of each group and acknowledge their work with any necessary feedback.
- Display the Hundredths grids and ask what decimal number does the grid represent (Encourage students to volunteer)



- Show one more example of the Hundredths grid and similarly ask about the Thousandths grid. Likewise ask about the Thousandths grid and discuss 2 to 3 examples using thousandths grid. Simultaneously demonstrate how 2- 3 decimal numbers can be illustrated in a single Thousandths grid using different colors.





Activity 2 (20mins)

- Form a group of six again and this time, let the children use the thousandths grid made available in the google sheet and ask each group to show 2 different decimal numbers with the given color in a single Thousandths grid. Also let the students write their names. For example;

Follow- up (10 mins)

- Present all the groups work and examine together. Acknowledge and provide necessary feedback accordingly.

Closure (20 mins)

- Ask them to write any two decimal numbers and represent on a
    - Single thousandths grid and
    - Place value chart

- Explain how to do the task in the Google slide and tell them to submit in the Google classroom.

  Criteria for individual Assessment

Submission Date (1 m)	**Use of Google Slide (1m)**	**Presentation of the task (1m)**	**Correct Use of Method (2m)**	**Total (5m)**
As per the requirement of the teacher	Creativity in using the slide	Clarity of the work	The process of using the methods correctly	

Lesson Plan No: 2

Class: V **Subject: Mathematics**

Topic: Explore: Adding & Subtracting Decimals

Time: 90 Mins

Teaching Learning Material: Projector and Computer Desktop

Lesson Objective (s): By the end of the lesson, each student will be able to:

- Find the sum and differences of the hundredths decimal numbers.
- Use the grids, stripes and squares to find the sum and differences
- Demonstrate how to trade and regroup in adding and subtracting.

<u>Lesson Introduction (20 mins)</u>

- Exchange greetings with the class and have the students seated comfortably.
- Revisit the previous lesson by asking a few questions.
  1. What do you remember about the previous lesson “Decimal Thousandths”.
  2. Show the following decimal numbers in the single decimal thousandths grid.

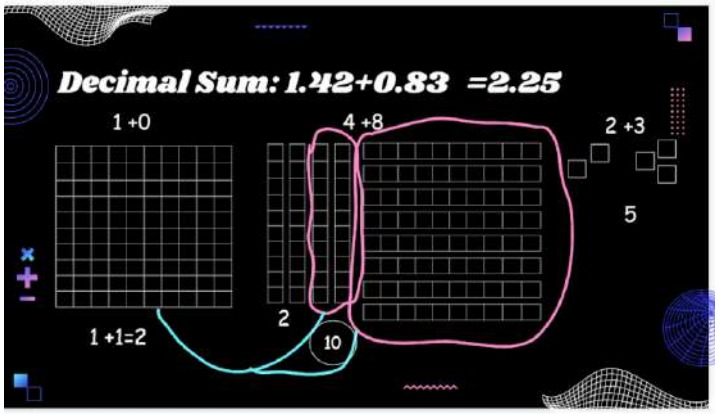
1. 0.263 2) 0.348 3) 0.365

- Have the volunteers do the task on their respective desktop in a google sheet linked to the shared Google slide. However, their work will be simultaneously projected.
- Once the above activity is done, have one more volunteer to drag and write the digits of a decimal number correctly in a place value chart. Let them identify the place value of each digit of a number. (This will also be projected)
- After the completion of the revision activity, acknowledge and provide necessary feedback for further clarifications. .
- Show the Title, "Explore: Adding & Subtracting Decimals".

Lesson Development/ Activities (40 mins)

- **25 mins**

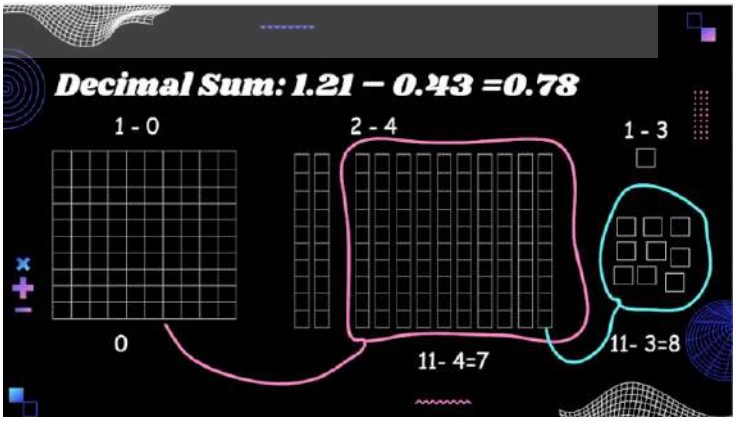
- Show students a decimal hundredths grid. Ask students how to model various decimals, for example, 0.23 (as 2 columns and 3 more squares) or 0.7 (as 7 columns). Then show how you can use a small square to represent 0.01, a strip (column) to represent 0.1, and a full grid to represent a whole number
- Explain the difference between adding the following decimals
    - 2.43 + 3.25 (We can just add each digit and need not have to trade and numbers)
    - 1.42+0.83 (While adding the number, if the following digit's sum has 2 digits, we need to trade)
- Model a decimal sum to explain about **trading** in addition, For example; 1.42 + 0.83,
    - Represent and explain the sum as a combination of
        - 1 + 0 using 10-by-10 grids (Hundredths grid)
        - 4 + 8 using a 10-by-1 grid (Strips), and
        - 2 + 3 using 1-by-1 (squares). Point out that to get the final sum, ten of the (4 + 8) strips could be traded for one more whole.



Explain how it is easier to remove 0.41 from 0.93 than 0.43 from 1.21.

- I have nine strips and three small squares so it is easy to remove four strips from nine strips and one small square from 3 strips. But if I wanted to remove four small squares and I had only two, I would have to do some regrouping.)

- Model a decimal difference, for example; 1.21 – 0.43,
  - Also represent the difference with Hundredths, tenths and ones model. Explain by
    - Starting with one 10-by-10(Hundred) grid, two 10-by-1 strips, and one 1-by-1 grid.
    - Then remove four squares (trade from the 10-by-10 grid (Hundred grids) for 10 strips and then remove four of them. To remove three small squares, you could trade one of the 10-by-1 strips for ten small squares, and then remove three of them.



Activity 1 (15 mins)

- Tell the students to form in pairs and have them create a presentation slide each in a google slide for the following decimal numbers.

    a) 2.34+0.78

    b) 2.32 - 1.65

    Note: Tell them to mention their names in the presentation. (Compile the list of pairs and name them as 1-16)

- Observe while students work and guide them in making the presentation slide.
- Have the students submit their work in the google classroom folder. (Open the folder and randomly show the presentation of few students)

Follow- up Activity (15 mins)

- Discuss about how to do trading and regrouping while doing addition and subtraction of the decimal numbers.
    - ➢ Why can you add the digits to find out how many models you need? (Each digit tells me how many of a certain type of model I need, so when I add the digits, I find out how many of each type of model I need.)
    - ➢ When you regroup, why are there always nine more or fewer models than you had before? (Each model is worth 10 smaller models. So, for example, if I trade one strip for ten small squares, I lose one strip but I add ten other models, and 10 – 1 = 9.)

Closure (15 mins)

- Summarize the lesson by revisiting the slides of the lesson by focusing on the following terms.
    1. Addition, sum, trading
    2. Subtraction, difference, regrouping

APPENDIX D

IOC FOR LESSON PLAN

IOC FOR LESSON PLAN BY THE EXPERTS

Item 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
5	Lesson plan 5	+1	+1	+1	+1	congruent
6	Lesson plan 6	+1	+1	+1	+1	congruent
Overall Average		**+1**				**Congruent**

APPENDIX E

LEARNING ACHIEVEMENT TEST

LEARNING ACHIEVEMENT TEST

Class: 5 **Subject: Mathematics**

Topic: Decimals **Total: 20 marks**

Part A

Direction: Each statement is followed by four possible answers. Choose the most correct answer and write it in the space provided.

(2 x 5= 10 marks)

1) In the decimal number 3.2486, the digit 4 is in ……?

A Hundredths place
B Ten Thousandths place
C Thousandths place
D Tenths place

Ans: ……

2) The Indian Ocean covers 174 thousandths of the earth's surface. Which of the following

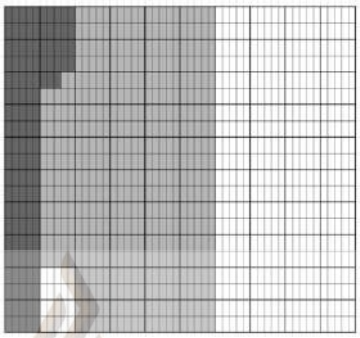
represents the correct decimal?

A 174.
B 0.174
C 0.0174
D 0.00174

Ans: ……

3) Which Addition does the given model represent?

A 0.123 + 0.457



B 1.230 + 4.570

C 12.30 + 45.700

D 123 + 457

Ans: ……

4) Which is the greatest?

A 2.678 + 9.149

B 5.982 + 6.181

C 3.019 + 0.921

D 1.625 + 4.242

Ans: ……

5) Phuntsho is 143.6cm tall. Dawa is 2.5cm taller than Phuntsho. How tall is Dawa?

A 144.0 cm

B 145.1 cm

C 146.1 cm

D 147..0 cm

Ans: ……

Part B

Question 6
Direction: Read the statement carefully and write **True/ False** against the statement.

[1 x 5= 5 marks]

Sl. No	Statement	True/ False
a	The decimal point is always placed between the **Ones** and the **Tenths** place.	
b	0.271 is 2 hundredths and 71 thousandths.	
c	4.186 > 1.423 + 2.921	
d	4.33 - 1.482 is 2.848	
e	13.799 + 4.285 = 9.084	

Part C

Direction: Answer all the questions. The marks for each question are provided in the bracket. **[5 Marks]**

Question 7

Draw a place value chart and write a decimal in it to match each description. [2m]

a. A decimal with 1 in thousandths place and 0 everywhere else.

b. A decimal with 4 in hundredths place, 1 in tens place, 3 in tenths place and 0 everywhere else.

Question 8

The liquid in the four identical large containers was measured. If the contents of two fullest containers were put together, how much liquid would there be? [1m]

3.245 1.262 L 1.283 L 2.157 L

Question 9

Using a number line, find the difference between 3.232 - 0.265 [1m]

Question 10

Sonam's gold ring has a mass of 12.634 g. Pema's gold ring has a mass of 16.386 g. How many more grams of gold are there in Pema's ring? [1m]

Test Blueprint

Content	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Total
Decimal Computation	Q.6a (1)	Q.2 (2) Q.5 (2)	Q.4 (2) Q.7 (2) Q.8 (1) Q.10 (1)	Q.1(2) Q.6b (1)	Q.3 (2) Q.6c (1) Q6d (1) Q6e (1)	Q.9 (1)	20
Marks	**1**	**4**	**6**	**3**	**5**	**1**	**20**

APPENDIX F

IOC FOR LEARNING ACHIEVEMENT TEST

IOC FOR LEARNING ACHIEVEMENT TEST QUESTIONS BY THE EXPERTS

Sl No.	Item Test No.	Expert 1	Expert 2	Expert 3	Average	Congruence
1.	Multiple Choice Q.1	+1	+1	+1	+1	Congruent
2	Multiple Choice Q.2	+1	+1	+1	+1	Congruent
3	Multiple Choice Q.3	+1	+1	+1	+1	Congruent
4	Multiple Choice Q.4	+1	+1	+1	+1	Congruent
5	Multiple Choice Q.5	+1	+1	+1	+1	Congruent
6	True or False Q.6.a	+1	+1	+1	+1	Congruent
7	True or False Q.6.b	+1	+1	+1	+1	Congruent
8	True or False Q.6.c	+1	+1	+1	+1	Congruent
9	True or False Q.6.d	+1	+1	+1	+1	Congruent
10	True or False Q.6.e	+1	+1	+1	+1	Congruent
11	Short Q/A.7.a	+1	+1	+1	+1	Congruent
12	Short Q/A.7.b	+1	+1	+1	+1	Congruent
13	Short Q/A.8	+1	+1	+1	+1	Congruent
14	Short Q/A.9	+1	+1	+1	+1	Congruent
15	Short Q/A.10	+1	+1	+1	+1	Congruent
Overall Average		**+1**				**Congruent**

APPENDIX G

SEMI-STRUCTURED INTERVIEW QUESTIONS

SEMI-STRUCTURED QUESTIONS

Sl. No	Questions	Interview Responses	
1	Could you describe how you usually learn Mathematics?		
2	What did you enjoy the most while participating in the classroom activities?		
		Web Applications	**Collaborative Learning**
3	Share your opinions on the use of the given tool and strategy in the learning of decimal computation.		
4	How did your friend help you in the learning process?		
5	Would you prefer to learn other topics through use of these learning tools and strategies? Why?		

(Adapted from Rigzin & Chalernmnirundorn. (2021) & Jamtsho, T. (2019)

APPENDIX H

IOC FOR SEMI-STRUCTURED INTERVIEW QUESTIONS

IOC FOR SEMI- STRUCTURED QUESTIONS BY EXPERTS

Sl. No	Items	Expert 1	Expert 2	Expert 3	Average	Congruence
1	Could you describe how you usually learn Mathematics?	+1	+1	+1	+1	Congruent
2	What did you enjoy the most while participating in the classroom activities?	+1	+1	+1	+1	Congruent
3	Share your opinions on the use of the given apps and strategy in the learning of decimal computation.	+1	+1	+1	+1	Congruent
4	How did your friend help you in the learning process?	+1	+1	+1	+1	Congruent
5	Would you prefer to learn other topics through use of these learning apps and strategies? Why?	+1	+1	+1	+1	Congruent
Overall Average		**+1**				**Congruent**

APPENDIX I

RELIABILITY TEST SCORES OF LEARNING ACHIEVEMENT

Reliability Test Scores of the Learning Achievement Test

Case Processing Summary

		N	%
Cases	Valid	31	100.0
	Excluded[a]	0	.0
	Total	31	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.773	.775	14

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
7.5806	10.852	3.29418	14

APPENDIX J

CONSENT LETTER FROM PARENTS

Parents' Consent Letter

Dear Parents,

Currently, I am pursuing a Master of Education in Curriculum and Instructions at Rangsit University in Thailand. As a part of my study, I am conducting my research on the "The Integration of Web Applications and Collaborative Learning in Mathematics of Grade Five Bhutanese Students". This research study necessitates the teaching of Mathematics lessons with student involvement during the school hours, and I am confident that my study will significantly improve their learning. The instruments for the study comprise a pretest and posttest, and semi-structured interview to collect the required data.

Therefore, I would like to seek your permission for your child to participate in this study. Their names, identifications and schools will be maintained as confidential or anonymous. I greatly appreciate your cooperation and support for the study.

Thanking You

Yours Sincerely

Pema Seldon
Student
Rangsit University
Thailand.

Parents' Consent Letter

I acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I have read the letter provided by Mrs. Pema Seldon and have agreed to allow my child (……) participate in the research as described.

Name: ……

Relation to the child: ☐ Parent ☐ Guardian Signature: ……..

Date: ……

APPENDIX K

PAIRED SAMPLE T-TEST

Paired Sample T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	10.24	31	3.04	0.55
	Posttest	14.44	31	3.15	0.57

Paired Samples 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	-4.20	2.70	0.49	-5.19	-3.21	-8.67	30	.01

BIOGRAPHY

Name	Pema Seldon
Date of birth	December 14, 1985
Place of birth	Samdrup Jongkhar, Bhutan
Education background	Samtse College of Education, Bhutan Bachelor of Education, 2008 Rangsit University, Thailand Masters of Education in Curriculum and Instruction, 2022
Scholarship	Trongsa Penlop Scholarship (TPS)
Address	Nangkor, Shumar, Pema Gatshel
Email Address	peseldon200901458@education.gov.bt pessel85@gmail.com