

# THE IMPACTS OF USING VISUAL IMAGES FOR MATHEMATICS ACHIEVEMENT OF GRADE 4 BHUTANESE STUDENTS

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#### Thesis entitled

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#### **Abstract**

This thesis examined the impacts of using visual images for mathematics achievement and learning satisfaction of grade 4 Bhutanese Students. The research sample consisted of 31 students from one of the middle secondary schools in Bhutan who participated in the study. A mixed-method approach was used in the research design to collect both quantitative and qualitative data. A pretest was conducted to assess students' prior knowledge and understanding of mathematical concepts. Following the pretest, visual images were integrated into the instructional materials during the teaching phase. Posttest was then conducted to measure the students' learning achievement after using visual images in the teaching process.

When the results of the pretest and posttest were analyzed using a Paired Sample t-test, it was found that the posttest (12.81) mean score was higher than the pretest (5.95) mean score, with a mean difference of 6.86. With a significance level of  $\leq$ 05, it was clear that using visual images helped students learn and understand the concepts of mathematics. Related results were found in the semi-structured interview data, which showed positive satisfaction. The findings sheded light on the relationship between the use of visual images and students' learning achievement and satisfaction in the context of mathematics education. The findings provided educators and curriculum designers information about the advantages of using visuals when teaching mathematics, which may improve students' comprehension and interest in the subject.

(Total 115 pages)

Keywords: Visual Images, Learning Achievement, Learning Satisfaction, Mathematics, Grade 4 Students

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#### **ABBREVIATIONS**

| Abbreviations | Meaning  |
|---------------|--|
| BCSEA         | Bhutan Council for School Examination and Assessment         |
| BHSEC         | Bhutan Higher Secondary Education Certificate                |
| BCSE          | Bhutan Certificate of Secondary School                       |
| PISA-D        | Program for International Student Assessment for Development |
| DCPD          | Department of Curriculum and Professional Division           |
| REC           | Royal Education Council                                      |
| IOC           | Item Objective Congruence                                    |
| MoE           | Ministry Of Education  |
| NNC           | New Normal Curriculum  |
| NSC           | National School Curriculum                                   |
| PPT           | PowerPoint Presentation                                      |
| TIMSS         | Trends in International Mathematics and Science Study        |

#### **CHAPTER 1**

#### INTRODUCTION

#### 1.1 Background and Rationale of the Study

Mathematics is an important subject that does not stop with learning but exists with humankind since it is connected to all occurrences of natural phenomena and their existence. The transformative potential of mathematics education extends beyond rote learning; it extends to cultivating essential life skills, career preparation, financial literacy, and technology proficiency (Liljedahl, Santos-Trigo, & Malaspina, 2016), as well as equipping people with problem-solving skills, logical reasoning, and creative thinking (Irina, 2021).

Most of the Bhutanese students struggle to understand mathematics since it was not taught in our context and thus ended up memorizing. Bhutan's mathematics curriculum underwent numerous rounds of revision to raise the standard of mathematics instruction, but there are several problems and difficulties with the curriculum that makes it difficult for students to learn. According to Dorji and Tshering (2020), the mathematics curriculum from fourth to twelfth grade is extensive and detailed, and because of this, it has been found that teachers compelled students to learn at a faster pace using the lecture method or by attending extra classes. There were also hints that teachers frequently focused on topics while purposefully omitting other concepts from the curriculum. The prevalence of word problems makes the curriculum from fourth to tenth grade particularly challenging. It was also evident that students frequently struggled to comprehend, visualize, and identify the patterns implied in the word problems (Dorji & Tshering, 2020). Mathematics textbooks often include illustrations, but they hardly ever encourage students to create images and visualizations.

As per Bhutan Council for School examination and Assessment (BCSEA) (2018 & 2019), the mean score in mathematics for grade three Bhutanese students was 56.5 and 64.02, respectively. These results revealed that, when compared to English and Dzongkha, Mathematics had consistently received the lowest scores for two years running running. Math received the lowest average mean grade over the course of two years (2017 & 2018), at 60.26, compared to 64.69 in English and 73.66 in Dzongkha. Similarly, BCSEA (2019) reported that the overall mean score in Mathematics for grade six Bhutanese Students was 35.33 and 43.33 for the academic year 2017 and 2018, respectively, which was also reported as the lowest compared to the other four subjects. As mentioned in Dorji and Tshering (2020) the Programme for International Student Assessment Development (PISA-D) test conducted by BCSEA (2017, 2019) stated that Bhutanese students performing much worse in mathematical literacy with mean score of 28.84 compared to the Scientific Literacy and Reading Literacy with mean scores of 41.78 and 37.41, respectively. The Bhutan Council of School Examination and Assessment (BCSEA) has published the Bhutan Higher Secondary Education Certificate (BHSEC) and Bhutan Certificate of Secondary Education (BCSE) results. The results revealed that the mean mark for mathematics in both examinations is comparatively the lowest compared to other subjects, which still indicates that we need to consider the alternatives (BCSEA, 2023). This might be because of a variety of factors, including poor teaching practices, limited access to resources, or a lack of sufficient motivation. ชยรังสิต Rangsi

It has been found that teachers who used a variety of teaching methods had more success in improving student performance than those who relied on only one method. Royal Education Council (REC, 2012) identifies that low math scores are primarily related to a fear of the subject and the teaching technique (traditional way of teaching). Furthermore, Dorji, Giri, Penjor, and Rinchen (2021) found that a variety of instructional methods are required to facilitate fruitful learning and results in the mathematics subject and its teaching. Some teachers even used uninspiring methods, which the students find obsolete and uninteresting. The fact is further supported by Abramovich, Grinshpan, and Milligan (2019) that instead of using traditional lectures and emphasizing the formality of mathematical equipment, we think it is more

appropriate to teach mathematics at all levels through applications. And they also believed that people who are learning mathematics are kept motivated by application to real-world situations.

According to Aladejana (2007), the teacher is normally seen and functions as the source of information in this pattern, which is conservative, and the students are the dormant recipients. Another factor that leads to low performance in mathematics could be anxiety. As per Dobson (2012), students who experienced anxiety exhibited poor academic performance. Furthermore, Sokolowski and Ansari (2017) claim that individuals who have 'mathematical anxiety' normally believe they are poor in mathematics and resent the subject. As a result, anxiety can be seen as the biggest obstacle that has contributed to students' negative attitudes toward mathematics and learning associated. There is abundant evidence that students' attitudes toward discipline can influence how well they comprehend the ideas and how well they can analyze the problems (Tsamir & Tirosh, 2002, as cited in Dolma, 2016). Children are more likely to enjoy and understand mathematical concepts when their level of comprehension is positive. It aids children in understanding abstract and difficult mathematical concepts, much like the visual image's strategy does. Therefore, children's attitudes toward mathematics because of the lecture method used in classrooms are a major factor in why they perform poorly in math.

There is a common understanding that students' attitudes toward mathematics evolve gradually because of being fully immersed in the atmosphere created by teachers in the entire proceedings. Students' perceptions of the nature of mathematics are significantly influenced by their beliefs about mathematics and mathematics education (Ernest, 1989, as cited in Dolma, 2016). To understand and redefine their pedagogical approaches, which will impact their students' accomplishments, teachers must first grasp their beliefs (Wilkins, 2008, as cited in Dolma, 2016). It is unreasonable to try and change teachers' practices without also considering their beliefs (Beswick, 2006, as cited in Dolma, 2016).

Accordingly, many studies have concluded that using the best visual images during the teaching and learning process will affect student learning outcomes. By using teaching strategies that are more interesting, enjoyable, meaningful, and engaging, this can be accomplished. Jalbani (2015) claims that Visuals and auditory aids are effective tools that teachers can use to engage their primary students, but the content and delivery methods must be well-crafted to provide maximum learning opportunities. Syofyan (2018) also concluded that learning style-shifts and learning opportunities should match the teaching strategies to meet the individual's learning style. Engaged students learn more effectively and students can be engaged when we facilitate learning by utilizing visual images like manipulatives, actual objects, and further incorporating technology. On this account Choden, (2021) also states that learners exhibited an elevated level of learning achievement in mathematics after using manipulatives which was further assisted by cooperative learning style as it was never perceived to be boring and tedious.

In this research, visual images refer to the use of real objects, manipulatives (pattern blocks), and PPT for learning fractions. Though PPT is no longer widely used in many of the technologically advanced countries, it is still used in a country like Bhutan that is still relatively new to technology. Tools like projectors and computers were used in higher grades for subjects like History and Geography but not in Mathematics curriculum. According to Subba (2011), some of the multimedia technology tools used in Bhutanese classrooms are the tape recorder, computers, projectors, CD ROMs, and OHP. Simple media like recorded sounds, rhymes and text were also rarely used in classroom of Bhutan forget about the use of PPT in primary schools. However, with the advancement of technology and the government's efforts to promote digital literacy, there has been an increase in the use of multimedia tools in Bhutanese classrooms, especially in urban areas. This has led to a more interactive and engaging learning experience for students. Nurmawati, Masduki, Prayitno, and Dartani (2020) found interactive multimedia-based learning media significantly improved mathematics understanding compared to conventional methods, with an experimental group scoring higher. According to a study done by Zacal (2014), multimedia use can lead to greater improvements in mathematics teaching. Additionally, according to Gracia (2019), 92.4% of students believe that they can learn more effectively when teachers use or incorporate technology in the classroom. In fact, the study conducted by Rinzin (2021) revealed that using technology in mathematics motivated and developed the participants' confidence in the subject, which is one of the key emotions.

It is proven that visual formats account for 75 percent of the information processed by the brain and as said by Williams (2009), visual information gets better mapped in the minds of the students when they get to see the material in the classroom. The cited material includes images, flowcharts, diagrams, videos, simulations, graphs, cartoons, coloring books, slide shows/PowerPoint decks, posters, movies, games, and flashcards, also known as visual learning (Rodger et al., 2009). The above-mentioned formats can be used by teachers to present enormous amounts of information in a straightforward way that demonstrates the linkage and the patterns, and the students can recall better when it is presented both visually and verbally. Visual teaching, as the name implies, uses images to present information to aid in students' understanding of innovative ideas, the connection between concepts, and the development of critical thinking ("Visual Teaching Strategies to Improve Learning," n.d.). Therefore, Visual teaching can be effective in engaging classrooms and helping students retain information but requires the right tools and strategies. Yung and Paas (2015) also explored how visual representations in the domain of mathematics can help improve learning performance and reduce cognitive load. Therefore, visual representation has been an alternative, recognized as a powerful learning tool in many learning domains.

Given the above consultation, it is apparent that teaching strategies and emotions towards the subject plays a vital role in students' learning outcome and satisfaction. Thus, this study intends to find out that integrating different visual images tools will impact teaching and learning mathematics. Also, teachers are becoming increasingly aware of the problem and searching for new effective ways through which they can teach more effectively. The researcher hopes that attitudes towards learning mathematics will be minimized as the lessons will be taught through this method, thereby making the learning exciting, hands-on experience, and joyful.

#### 1.2 Research Objectives

- 1.2.1 To study the learning achievement of grade 4 Bhutanese students before and after using visual images.
- 1.2.2 To investigate the learning satisfaction in Mathematics after using visual Images.

#### 1.3 Research Questions

- 1.3.1 Would there be any impacts on grade 4 Bhutanese students' learning achievement in Mathematics after using visual images?
- 1.3.2 Would there be learning satisfaction after using visual images in teaching. and learning mathematics?

#### 1.4 Research Hypotheses

1.4.1 Grade 4 Bhutanese students' learning achievement would be significantly improved after using visual images in teaching mathematics.

### 1.5 Scope of the Study

#### 1.5.1 Location of the study

This research was carried out in one of the Middle Secondary Schools located in the Western part of Bhutan under Chhukha Dzongkhag.

#### 1.5.2 Population and Sample

The population of the study was grade 4 students from one of the Middle Secondary School under Chhukha Dzongkhag. Though there were two sections of grade 4, the researcher considered one section of 31 students using a clustered random

sampling as a research participant to have the best result. The student participants were of mixed abilities, gender, and of different age groups ranging from 9-11 years.

#### 1.5.3 Content of the Study

In this study, the researcher instructed a lesson on fractions from a math textbook for grade 4. After the pretest and before the post-test, the researcher taught each of the four sub-topics in this chapter using real objects, manipulatives, and PPT as Visual Images.

Table 1.1 Table of content for the lesson

| Lesson | Topics    | Activities  | Time   |
|--------|-----------|---|--------|
| Plan   |           |   |        |
| I      | Pre-test  | - Using real objects recollects the meaning of                  | Second |
|        | Types of  | fraction learnt.  | week   |
|        | Fractions | - Techer shows the pattern blocks to the whole                  | of May |
|        |           | class and explain about their relationship.                     | 2023   |
|        |           | - Simultaneously participants will play with the                |        |
|        | 200       | pattern blocks to understand the relationship.                  |        |
|        | 723       | - Explain the types of fractions using PPT and                  |        |
|        | 7         | simultaneously teacher will supplement through question answer. |        |
|        |           | - Learning activity   |        |
| II     | Renaming  | - Teacher will recapitulate the previous lesson                 | Third  |
|        | fraction  | using their school shoes.                                       | week   |
|        |           | - Discuss and relate the fraction to real life                  | of May |
|        |           | situations like cooking, money, probability.                    | 2023   |
|        |           | - Through PPT present the concept of renaming                   |        |
|        |           | fraction.   |        |
|        |           | - Simultaneously the participants will play with                |        |
|        |           | pattern blocks to practice the concept.                         |        |

Table 1.1 Table of content for the lesson (Cont.)

| Lesson<br>Plan | Topics     | Activities  |         |  |  |
|----------------|------------|---|---------|--|--|
|                |            | - Participants will be also provided the work         |         |  |  |
|                |            | sheets to practice the concept.                       |         |  |  |
| III            | equivalent | - The teacher will screen short videos to relate to   | Fourth  |  |  |
|                | fractions  | the topic and discuss it accordingly.                 | week    |  |  |
|                |            | - Explain the concept through PPT incorporating       | of May  |  |  |
|                |            | other visual images as well.                          | 2023    |  |  |
|                |            | - Participants will practice the concept using        |         |  |  |
|                |            | pattern blocks and symbolically write equivalent      |         |  |  |
|                |            | fraction.   |         |  |  |
| IV             | Comparing  | - The teacher will distribute a loaf of bread to each | First   |  |  |
|                | and        | group to try this activity from the text.             | Week    |  |  |
|                | Ordering   | - The teacher will show the PPT slides and            | of June |  |  |
|                | fraction   | simultaneously participants will practice with        | 2023    |  |  |
|                |            | pattern blocks.                                       |         |  |  |
|                |            | - The teacher will further introduce the symbol       |         |  |  |
|                | 200        | and demonstrate.                                      |         |  |  |

#### 1.5.4 Time Frame

After the research proposal, the researcher went for the data collection, which took about four weeks to complete. The researcher taught a lesson for 90 minutes per week, and it took about four weeks to complete it. Altogether, the researcher taught 8 periods in four weeks using visual images. The data was collected in May and June 2023. Table 1.2 below shows the time frame of the study.

| Table 1.2 | т. т     | 7 (      | ` .1   | D 1          | D       |
|-----------|----------|----------|--------|--------------|---------|
| Table 1/  | I ime F  | rame t   | or the | Research     | Process |
| 14010 1.2 | 111110 1 | . rame i | or urc | 1 Coocai Cii | 1100000 |

| Activities        | From    |        | ТО       |      |
|-------------------|---------|--------|----------|------|
|                   | Month   | Year   | Month    | Year |
| Literature Review | January | 2023   | February | 2023 |
| Research Proposal | March   | 2023   | April    | 2023 |
| Data Collection   | May     | 2023   | June     | 2023 |
| Data Analysis     | July    | 2023   | August   | 2023 |
| Final Defense     |         | August |          | 2023 |

#### 1.6 Conceptual Framework of the Study

This study focused on the variables used in the research work. The two variables examined was the independent variable, which included the use of visuals images for teaching mathematics to class 4 students, and the dependent variable, which were the learning achievement and students' learning satisfaction. The framework is illustrated below:

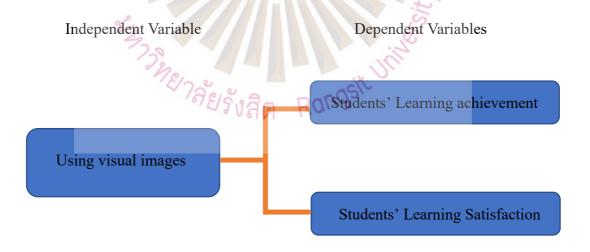


Figure 1.1 Illustration of the independent variable and dependent variables

#### 1.7 Operational Definition

**Visual Images:** In this study, a visual image is defined as the use of real objects (fruits, shoes, and pizza), manipulatives (pattern blocks), and digital pictures into PowerPoint presentations to provide a holistic approach to teaching fraction. This method relies on the strengths of both tangible and digital learning tools by explaining the process of transitioning from physical tools to digital images through PowerPoint presentations, providing students with a holistic and versatile learning experience that fosters a deep understanding of mathematical concepts.

**Students' Learning achievement** refers to the improvement in students' learning achievement after learning mathematics (fraction) using visual images. This can be identified from their achievement test scores of pretests and posttest in mathematics.

Students' Learning Satisfaction refers to research participants' positive responses towards using visual images in teaching and learning mathematics (Fraction). The satisfaction was measured from semi-structured interviews with the research participants after the use of visual images.

**Grade 4** Students refers to Bhutanese students studying in 4th standard: aged between 9-11 years and they are research participants of the study.

### 1.8 Significance of the Study

- 1.8.1 The use of visual images had a significant impact on learning achievement in mathematics in grade 4 Bhutanese Students.
- 1.8.2 The study showed the positive learning satisfaction of the grade 4 Bhutanese students in learning mathematics after using visual images.
- 1.8.3 The study would provide Mathematics teachers in Bhutan with an alternative teaching strategy to enhance learning achievement.

#### 1.9 Limitations of the Study

- 1.9.1 The study is limited to a section of grade 4 students in one of the middle secondary schools in Chhukha District, Bhutan. Therefore, the findings will not infer the performance of grade 4 students in Bhutan.
- 1.9.2 The study is limited to only one topic from the text of mathematics subject from grade 4 and so cannot be inferred to all the topics.
- 1.9.3 Among many visual formats, the study is limited to only three visual tools (real objects, PPT, Manipulatives) which are available and appropriate to teach the topic (Fractions) in the school. Therefore, the result may not be applicable to all the visual formats.



#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Concepts of Mathematics

Different definitions of mathematics have been offered by well-known mathematicians, philosophers, and reputable organizations. "Mathematics is a scientific discipline that deals with numbers and mathematical operations" (Fatima, n.d.). According to Hom (2013), mathematics is a science that studies the structure, order, and relationship of counting, measuring, and logical reasoning. Every person uses mathematics in the form of tools, building blocks, money, art, and sports. Additionally, Rayan (2023) asserts that mathematics is often called the universal language. It is a tool that enables us to explain and comprehend everything around us, from the simplest equations to the most complex systems. Mathematics provides a common ground for people of diverse cultures and languages to communicate and understand each other. It also plays a crucial role in various fields such as science, engineering, economics, and technology.

Mathematics value extends beyond the academic and professional fields. Advanced cognitive skills are directly correlated with math proficiency. Efficient math teaching and consistent practice can strengthen brain functions such as: problem solving, planning, attention, memory, life skills, career and finance, and technology. As a result, it is crucial to prioritize math education from an early age to provide people with the skills they need for success in a variety of areas in their lives. Incorporating practical uses for math ideas can also improve students' comprehension and relevance of the subject. As per Zain (2021), mathematics assists in our comprehension of the world and is a useful tool for building mental discipline. Features like Logical and critical thinking, innovative ideas, abstract or spatial intelligence, problem-solving talents, and solid corporate communication skills are all

valued in math. Mathematics is not only useful in academic settings but also in everyday life, as it helps individuals make informed decisions and understand complex situations.

Educating pupils and students for technical practice is essential to help them find jobs and be successful in the labor market. Modern teaching methods such as graphic programs and teaching mathematics by means of discovering new concepts should be used to involve primary-school pupils and secondary-school students in the learning process (Hodaňová & Nocar, 2016). Yet, Rayan (2023) feels that mathematics is more than just a tool for understanding the natural world and the universe; it has a wide variety of practical applications. Mathematics has contributed to the creation of several areas that have revolutionized our world, from encryption to computer technology. It is the foundation of modern technology, from search engine algorithms to encryption that protects our online conversations. Furthermore, mathematics has also played a crucial role in the advancement of fields such as finance, engineering, and medicine. Its ability to model complex systems and make accurate predictions has made it an indispensable tool for decision-making in these industries. As such, mathematics continues to be a vital subject for students to learn and master.

# 2.2 Mathematics Curriculum in Bhutan

Tshewang (2015) describes the curriculum as the central component of an educational system, with classroom learning. He also emphasizes the significance of teachers in implementing the curriculum because it is up to them to present the material and modify it to suit the requirements of their pupils. To execute curriculum effectively, teacher training and professional development are essential. The Council for the Indian School Certificate Examinations (CISCE), New Delhi, India, previously had affiliations with the Bhutan Certificate of Secondary Education (BCSE) and the Bhutan Higher Secondary Education Certificate (BHSEC). Bhutanese students thus studied Indian content and took Indian exams for several decades. This meant that Bhutan did not, for a long time, revise the curriculum to better reflect its own history and values (Thinley, 2013, as cited in Dolma, 2016). As a result, the education system

in Bhutan was heavily influenced by India and lacked a keen sense of cultural identity. However, in recent years, Bhutan has made efforts to develop its own unique curriculum and promote its own cultural heritage in schools.

With the beginning of modern education in Bhutanese schools in the early 1960s, led by the third king, mathematics education was formally and thoroughly introduced to the country's educational system. During those years, math classes were commonly taught by Indian teachers and introduced in a very formal, abstract way that modeled Indian practices. The lack of opportunities for students to actively participate in the teaching and learning process limited their ability to construct their own knowledge, which led to a lack of conceptual knowledge and a focus on procedural understanding. This approach to learning math also contributed to an overemphasis on rote memorization of formulas and procedures rather than developing critical thinking skills. The National Board of Examinations results, which revealed that very few people chose to study mathematics at universities and colleges, provided evidence of this (Dolma, 2002).

In Bhutan, reform to set higher standards for teaching mathematics began gradually in the late 1980s. According to McLean and Hiddleston (2003), the new thinking was primarily based on challenging the Bhutanese educational system's necessities, needs, and aspirations. Early in the 1990s, lecturers from Bhutan's two education colleges as well as experts from universities in more developed nations—primarily the United Kingdom—were invited to share their perspectives with the country's math educators. This exchange of ideas led to crucial changes in the Bhutanese education system, including the implementation of new teaching methods and a greater emphasis on critical thinking skills. The two colleges' lecturers participated in a few sessions of professional learning activities throughout the process, which gave them some exposure to teaching in Bhutanese context.

A few groups of lecturers from Bhutan's teacher-training colleges were also sent to the University of Leeds between 1990 and 1994 to complete a one-year Advanced Diploma in Educational Studies in a variety of subjects, including mathematics. Later, more math educators from Bhutan were sent to universities in Australia and Canada to expand their exposure. Therefore, over the past 20 years, Bhutan has used international practices to inform the localization of its educational system, both by hiring its own Bhutanese teachers and by substituting a Bhutanese curriculum for English and mathematics for the previous Indian curriculum (Fricot, 2009). These programs aimed to enhance the quality of teaching in Bhutan by providing educators with advanced training and varied international exposure. This approach has been successful in ensuring that students are taught material that is culturally relevant and applicable to their daily lives.

As stated in the REC (2022), the National School Curriculum intends to shift education away from teaching "what" toward studying "how" and "why," preparing students with 21st-century skills and transversal competences and encouraging a lifelong desire to learn. The rational and sequential development of mathematical concepts within and across class levels lays out the abilities necessary to produce a mathematically literate society. Mathematics education plays a crucial role in achieving the goals of the National School Curriculum by developing critical thinking, problem-solving, and analytical skills that are essential for success in the 21st century. Therefore, it is necessary to provide students with a strong foundation in mathematics that will enable them to apply mathematical concepts to real-world situations.

In response to the results of the 2003 National Educational Assessment, the Ministry of Education decided to review the mathematics curriculum, considering the advice of unbiased outside advisors. This started in 2003, when two European consultants (i.e., British), Dr. McLean and Dr. Hiddleston, carried out an extensive study of mathematics instruction in Bhutanese schools. The Ministry of Education in Bhutan (2009) stated that they were the first group of academics to make strong recommendations for an immediate review and reform of the mathematics curriculum. Based on these recommendations, a Canadian consulting team and their Bhutanese associates started developing the mathematics curriculum framework from Class PP to 12 in 2005 (Ministry of Education, 2007). The implementation of this curriculum framework aimed to improve the quality of mathematics education in Bhutan and

enhance students' mathematical reasoning and problem-solving skills. It also aimed to align with Bhutan's overall education goals and the country's unique cultural and social context.

The new mathematics curriculum is intended to promote a thorough understanding of mathematical patterns, emphasize the reasons why mathematical patterns hold true rather than just the fact that they do, or place more emphasis on reasoning and contextualization in the context of the local area (Dolma, 2016). The new mathematics curriculum's main goal was to promote the use of constructivist teaching methods. This aimed to change the learning environment from a traditional chalkboard-dominated teaching style to one that emphasizes group and pair work and places more emphasis on teacher-student communication (Tshewang, 2015). One outcome of constructivist teaching methods is the development of critical thinking skills, as students are encouraged to actively engage with the learning material and collaborate with their peers. Moreover, these methods can enhance students' motivation as they are given greater autonomy and control over their learning process.

However, according to research by Dorji and Tshering (2020), teachers have been forced to use methods like the lecture method, accelerated learning, and supplementary courses since the mathematics curriculum, which is taught from fourth through twelfth grades, is extensive and rigorous. Moreover, it seemed fragmented or disjointed, with students receiving insufficient preparation for material covered in 11th and 12th grade by virtue of concepts covered in the ninth grade.

The New Normal Curriculum (NNC) was launched in 2021 in response to the COVID-19 situation. It focused on blended learning and focused on competency development. A year of implementation of National School Curriculum (NSC) has enabled the DCPD to carefully study the nuances and associated challenges highlighted by teachers. With the current NSC, teachers should be able to give students learning opportunities that will support the development of their cognitive, performance, and behavioral skills (REC, 2022). The NNC has been designed to ensure that students can continue their education even in the face of future disruptions.

It emphasizes the use of technology and digital resources to create a more flexible and resilient learning environment. The 21st Century Education framework emphasizes a theme-based learning approach that broadens opportunities for experiential learning contextualized to the learner's physical, social, political, economic, spiritual, and cultural setting. This requires learning through active engagement of learners. The role of teachers, therefore, is transformed from knowledge transmitter to facilitation, guide, evaluator, researcher, and motivator (REC, 2022, p.vi.)

#### 2.3 Importance of Visual Images as an Instructional Tool

The term "Visual Images" refers to real objects, manipulatives (pattern blocks), and PowerPoint presentations (PPT) for this study. It also refers to the ability to accurately represent concepts as images to demonstrate their relationship to mathematical problems. A strong foundation for learning more advanced mathematical concepts is laid by the teaching method, which helps students justify their arguments using a variety of techniques (Kaitera & Harmoinen, 2022). Visual images are often used in teaching mathematics to enhance students' understanding and retention of concepts. The use of visual images is particularly effective for students who struggle with abstract concepts. Shabiralyani, Hasan, Hamad, and Iqbal (2015) stated that visual images can enhance students' learning experiences and make the classroom environment more engaging, helping them retain information better and improving their academic performance. Aso (2001) also supports that a figure can help us understand mathematical concepts and provide clues for solving problems. It can be a concrete expression or a visual image of the concept, with no words other than its title.

According to Pashler, McDaniel, Rohrer, and Bjork's (2008) analysis, the learning styles hypothesis claims that the same kind of instruction is most effective in all contexts and with all learners, but the best instructional strategy is going to differ across disciplines. For instance, various subjects call for various forms of instruction that are designed to make them simpler to comprehend. For writing, a verbal emphasis might be helpful, but for geometry, which needs visual-spatial materials, it would not be the best approach. Therefore, the researcher wants to find out the impacts of

learning achievement and learning satisfaction of grade 4 Bhutanese students after using visual images to teach the concepts of the fraction.

Schwarz (2016) offers additional evidence for the researcher's justification for the strategy chosen, which is that for students to develop a solid and mature understanding of fractions, they need numerous opportunities to engage with various interpretations of the concept. Students need to be exposed to a variety of methods for visualizing mathematical concepts to develop a collection of mental images that contribute to a deeper abstract understanding of a concept (Moyer, 2001). Visual image's approach to mathematics can help students gain access to deep and new understandings. Good mathematics teachers use visual images, manipulatives, and motion to enhance students' understanding of mathematical concepts. Visual images can also help students see the connections between different mathematical concepts and make sense of abstract ideas. Additionally, using visual images can increase student engagement and motivation in mathematics. To determine the impact of learning achievement and satisfaction, the researcher is integrating various forms of visual images, such as real objects, manipulatives (pattern blocks), and PowerPoint presentations (PPT).

#### 2.3.1 Visual images as an instructional tool in Bhutanese context

As per the study conducted by Galey (2016), the textbooks for classes 4-6 also showed that fraction operations and concepts were not demonstrated using various representations. It was also noted that rules were mentioned in the textbook at the start of each new concept, which encouraged the use of rules in teaching and learning. According to Miriria, MutambaraLillias, and Chagwiza (2012), "teaching by rules makes the classroom unproductive" (p.91). Students need to have a solid understanding of and skill with the algorithm, which is why teaching fractions should connect visuals with the procedures (Walle, Karp, & Bay-Williams, 2015). According to Hartung (1958, as cited in Yusof & Malone, 2003, p. 1), "The idea of fractions is complicated and cannot be mastered entirely at once. It can only be obtained after a lengthy period of successive development." Even though teaching and mastering

fractions are hard and abstract, it is taught in Bhutanese schools beginning in preprimary. Due to the difficulty, it frequently presents for students, the researcher decided to focus on fractions for this study. Teachers must provide pertinent experiences to improve students' informal understanding of fractions and aid in the connection between procedural knowledge and conceptual understanding because students have fewer experiences outside of the classroom with fractions than with whole numbers (National Research Council, 2001). Building an understanding of fraction computation requires the development of visual images for fractions. However, traditional fraction computation instruction frequently relies on rules.

One of key competencies of mathematics education in Bhutan is digital competence. The use of digital technology in mathematics instruction and learning can boost students' technological literacy and confidence. Digital competence is essential in preparing students for the demands of the 21st-century workforce, and it also enables them to access a wealth of online resources and tools that can enhance their learning experience (REC, 2022, p. 4).

Technology will have an impact on how well students learn because one of the visual tools the researcher will use is a PowerPoint presentation. According to Bhutan's Draft National Education Policy (2019), the curriculum should place a strong emphasis on the use of pedagogical approaches that encourage active student participation, communication, collaboration, creativity, and critical thinking as well as the development of competencies and the use of ICT in teaching and learning. ICT in the classroom significantly impacts students' learning attitudes, creativity, knowledge construction, the learning environment, teaching methods, problem-solving abilities, and comprehending concepts using a variety of tools. A student has the chance to store information in electronic format and comprehend various concepts based on it. Students can better understand mathematical concepts by using the visuals, simulations, and representations offered by ICT technology, according to DCPD (2022, as cited in Seldon, 2022).

Math education has typically been delivered in classrooms, with teachers giving factual material and then administering examinations to check students' memory of concepts (Hallström, Hultén, & Lövheim, 2013). Such pedagogical techniques deprive students of the opportunity to participate in meaningful learning experiences, which are provided through engaging classes in which students actively participate in cooperative learning activities (Nel, 2017). Teachers should employ a wider range of instructional materials, pedagogical tactics, and learner models as students go from tangible to abstract mathematical ideas to promote meaningful student involvement (Hallström et al., 2013).

A well-known Chinese proverb declares that "one sight is worth a hundred words." It is a fact that our intellect is how we learn new things. Another saying goes, "If we hear we forget, if we see we remember, and if we do something we know it." This implies that visual images impact the effectiveness of teaching and learning mathematics. There are many benefits to using visual aids in the teaching and learning process (Mohanty, 2001, as cited in Shabiralyani et al., 2015). Speakers can deliver a more polished and reliable performance when using visual images. Modern math lessons must foster students' independent thought and creative activity as one of their requirements. The students learn how to analyze, synthesize, compare, generalize, and draw conclusions. Students are better able to solve complex problems and think critically if independent thinking and creativity are encouraged. These mental operations aid students in understanding mathematics more thoroughly and using it in a practical setting. Thus, the researcher chooses to use real objects, PowerPoint presentations, and manipulatives (pattern blocks) in this study to find out the impact of learning achievement and learning satisfaction.

#### 2.3.2 Use of Real Objects- Connection of Concepts to Real World

Real objects that we see around us can also be effective tools for learning mathematics (Gadanidis, 2012). Real things serve as a link between the Real World and the Mathematical World. Students can use tangible things to develop a step-by-step method that helps them to visualize an abstract problem in phases, making it

easier to comprehend. Students can more easily access mathematical knowledge when they understand how to illustrate and manipulate abstract concepts using common objects (Devlin, 2000; Maccini & Gagnon, 2000; Witzel, Smith, & Brownell, 2001). A growing number of math teachers acknowledge that relating academic mathematics to real-world events, circumstances, and contexts—including students' own experiences and understandings of the world—is essential to student learning (Ladson-Billings, 2009; Turner et al., 2014; Turner & Strawhun, 2007). Furthermore, the National Council of Teachers of Mathematics (2000) stated the use of real objects in mathematics education can help to make abstract concepts more concrete and accessible for students, as well as provide opportunities for the real-world application of mathematical concepts.

According to the Ministry of Education and Skills Development (MoESD), (2023), the purpose of the National School Curriculum (NSC) in Bhutan is based on the principles of competency-based education (CBE), which emphasizes the application of skills and knowledge in real-world situations and is centered around the learner. When real-world applications are incorporated into lessons, students can see how math is used in their everyday lives. In turn, math stops being a set of impersonal rules and ideas restricted to the classroom and starts to become a significant phenomenon in their everyday lives.

Measuring cups and spoons can be used to teach fractions, as students can visualize the relationships between different fractions of a cup or a spoon. Similarly, clocks can be used to teach time and fractions, as students can see the relationship between hours, minutes, and seconds (Kieran, 2007). Additionally, shapes and patterns found in everyday objects, such as tiles or wallpaper, can be used to teach geometry and spatial reasoning. Objects like coins can be used to teach probability. Non-standard objects can be used to teach estimation and measurement in lower grades. These real-world contexts are often starting points to develop abstract thinking (Povey, 2013, as cited in Wuolle, 2016). "A little creativity and enthusiasm are as effective as cutting-edge tools for teaching mathematics to young children, physical mathematics teaching aids can engage children's minds in valuable ways that result in high retention of the information" (Jones, 2017, p. 18)

#### 2.3.3 PowerPoint presentation (PPT)

ICT and educational innovations have brought education and success closer together, integrating ICT into modern education standards' new foundation. Teachers can use a variety of helpful tools to provide students with the materials and content they want if they are familiar with various teaching techniques (Shah, T., Patel, & Shah, H., 2017). Using information and communication technology (ICT) in the classroom has been shown to increase student achievement and motivation in schools with and without adequate resources (Mensah & Nabie, 2021).

PowerPoint is a versatile tool that can be used to teach mathematics to primary students in an engaging and interactive way (Lari, 2014). Teachers can use the software to create presentations that incorporate colorful graphics, animations, and videos to help students visualize mathematical concepts. Interactive features such as quizzes, polls, and games can also be added to the presentation to make it more engaging and fun. In addition, PowerPoint allows teachers to easily create and share handouts, worksheets, and other materials that can be used to supplement classroom learning. Research has shown that using PowerPoint can be effective in improving mathematics achievement among students (Mensah, Sam, & Armah, 2022). However, PowerPoint's effectiveness depends on the presentation's quality and the teacher's role in using it effectively (Bruder & Roick, 2014). Overall, using PowerPoint can help make mathematics lessons more engaging and effective for primary students.

As per Hashemi, Azizinezhad, and Farokhi (2012), PowerPoint has become increasingly popular in schools and language classrooms, with more teachers using it and producing their own presentations. PowerPoint presentations can make learning more interactive and engaging for students, as teachers can incorporate multimedia elements such as videos and images. PowerPoint allows teachers to organize their lessons in a clear and concise manner, making it easier for students to follow along. Furthermore, teachers do not need to go through any advanced training to integrate PPT into instructional delivery because most teacher training institutions equip their prospective teachers with the ability to use PPT in teaching. One advantage of PPT is

that, once installed on a computer, it can be used to prepare concept slides without internet connectivity, allowing it to be used even in remote areas with limited or no internet access. Using PowerPoint in instructional delivery has been shown to improve students' academic performance and eliminate gender disparities in achievement (Gambari, Yusuf, & Balogun, 2015; Mensah & Nabie, 2021). Also, PPT allows for multimedia such as images, videos, and audio which can enhance student engagement and understanding of complex concepts. This feature also provides an opportunity for teachers to create interactive lessons that encourage student participation and collaboration. Ozaslan and Maden (2013, as cited in Mayer & Moreno, n.d.) concluded that students would learn the material more effectively if it were presented visually. Additionally, they stated that teachers thought PowerPoint presentations attracted students' attention by making the content more appealing.

In summary, the integration of real objects, manipulatives, and digital images within PowerPoint presentations forms a comprehensive approach to teaching fractions. This method capitalizes on the strengths of both tangible and digital learning tools, providing students with a holistic and versatile learning experience that fosters a deep understanding of mathematical concepts.

# 2.3.4 Manipulatives (pattern blocks)

One of the math tools that works well for teaching geometry is pattern blocks. However, pattern blocks can also be used to improve understanding of ideas like fractions, counting, and patterns. These building blocks are available in a variety of shapes, including triangles, squares, rectangles, and trapezoids, and can be made of either plastic or wood (Math Manipulatives: How Can They Be Used to Enhance the Classroom Experience? n.d.). Manipulatives have the added benefit of engaging students and boosting interest in and enjoyment of mathematics in addition to their capacity to directly support the cognitive process (Hand2Mind, 2017). Another definition of manipulatives is tangible items used as teaching aids so that students can practice their math skills (Staff, 2019b). According to Moyar (2021), visual learning is especially advantageous for people who have a visual learning style, which means

they comprehend information better when it is presented visually rather than verbally or in writing. Visual aids can still be helpful in enhancing learning outcomes and supplementing conventional teaching strategies for people who do not have a visual learning style. With the aid of manipulatives, students can learn by doing and exploring mathematical ideas in a concrete way. Students can better comprehend and retain information by using multiple senses, which results in a deeper understanding of mathematical concepts. Manipulatives are any object that can be used for teaching and learning mathematics concepts (Larbi & Mavis, 2016).

Students can more easily access mathematical knowledge when they understand how to illustrate and manipulate abstract concepts using common objects (Devlin, 2000; Maccini & Gagnon, 2000; Witzel et al., 2001). For instance, students can explore how many shapes are needed to make a whole or compare the size of two shapes to determine which one represents a larger fraction. Using pattern blocks in this way can help students develop a deeper understanding of fractions and their relationships. Therefore, the two figures below help to further illustrate how pattern blocks can be used to explore fractional concepts.

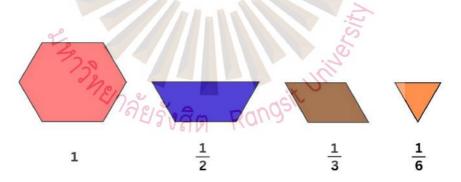


Figure 2.1 Set of pattern blocks that can be used to explore Fraction Source: Witzel et al., 2001

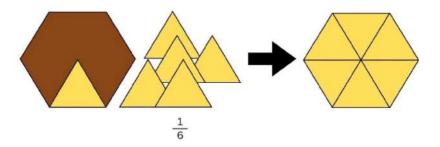


Figure 2.2 Pattern blocks showing Fractional Relationships

Source: Witzel et al., 2001

The "whole" in this example is one block, and the student is determining what fractional part of the whole a smaller figure would be. This simple math problem demonstrates a few crucial mathematical ideas. First, the concept of part whole relationships is introduced by asking students to justify the size of one shape in terms of the size of another shape. Second, students are applying the idea that fractional partitions must also be the same size by tiling the entire with a few identically sized blocks (e.g., that each one-sixth section of the whole will be the same size). This problem also helps students develop their spatial reasoning skills by requiring them to visualize and compare the sizes of different shapes and fractions within a larger whole. Additionally, it sets the foundation for more complex fraction operations and problem-solving in later math education.

According to Dayame (2019), he produced the findings that when the students undergo intervention there are great possibilities to improve the students' performance in terms of conceptualizing fraction using manipulative and visual models. Further he discovered that introducing students to a variety of techniques for enhancing conceptual understanding, such as the use of representations, models, and various manipulatives, can help students improve their academic performance. This finding highlights the importance of incorporating diverse teaching methods in classrooms to cater to different learning styles and enhance students' comprehension and retention of complex concepts. Educators can benefit from adopting a multifaceted approach to teaching that includes visual aids, hands-on activities, and other interactive techniques.

# 2.4 Conceptual Framework for using Visual Images in Teaching Mathematics

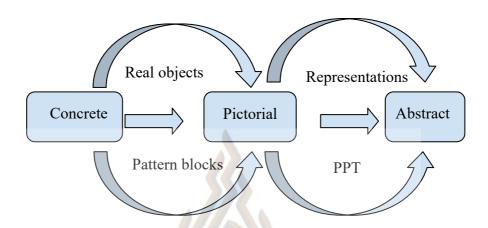


Figure 2.3 Framework of integrating visual images in teaching mathematical concepts

Source: Bruner & Kenney, 1965

The concrete-representational-abstract (CRA) sequence of instruction offers the framework for achieving the objectives set forth by the National Mathematics Advisory Council and the requirements of the Pennsylvania Academic Standards for mathematics education to prepare students for success in the mathematics classroom. CRA is an intervention for mathematics instruction that may improve students' mathematical performance in a classroom, according to research. Its foundations can be found in Bruner and Kenney's (1965) definition of learning as occurring in "Stages of Representation." Students learn in three stages: first, by physically manipulating concrete objects; second, by pictorial representation of the concrete manipulations; and third by solving problems using symbols (abstract).

1) Concrete. Concrete objects are used to model problems during the "doing" stage. The teacher begins instruction by modeling each mathematical concept using concrete materials during the concrete stage (e.g., real object, pattern blocks). This stage is particularly useful for students who are visual or kinesthetic learners, as it allows them to physically manipulate objects and see how mathematical concepts work in a tangible way. As students become more comfortable with the concrete materials,

they can then move on to more abstract representations of the same concepts.

- 2) Representational. Problems are modeled in the "seeing" stage using representations of the objects. During this phase, the teacher converts the concrete model into a representational (PPT) level. This may entail drawing pictures, using any appropriate 2D shapes and relating to symbols on images. Seeing the stage is a crucial step in problem-solving as it allows students to visualize and understand the problem before moving on to more abstract representations. By using different tools and techniques, teachers can help students develop their problem-solving skills and improve their ability to think critically.
- 3) Abstract. In the "symbolic" stage, problems are represented by abstract symbols. At this point, the teacher represents the number algorithm as a symbolic representation of the mathematical concept using numbers, notation, and mathematical symbols operation symbols as fraction are used by the teacher to denote three types of fractions. The symbolic stage is a crucial step in the learning process as it helps students understand the underlying concepts of mathematics and how they can be applied to solve problems. It also prepares them for more complex mathematical concepts that they will encounter in higher education.

Fig 2.3 presents the framework proposed for the teacher and students to be involved in the teaching learning process. It shows the procedures that the teacher will follow to integrate the manipulatives (Real Objects, Pattern blocks) and technology (PPT) to teach the concept (Fractions). (Bulut, ömlekolu, Zkaya-Seçil, Yldrm, & Tuncay-Yldz, 2006, as cited in Mehmet, Sari, & Aydogdu, 2020), tangible and technology-assisted learning are critical because they allow abstract mathematical ideas to be expressed practically, making mathematics meaningful for students, and because they contribute to establishing an environment in which students can experience what they are learning.

Therefore, using the visual images, the teacher will use real objects like fruits, shoes, and pizza to check their prior knowledge of the topic; the students will have a responding activity, where they will experience learning by doing. Then the teacher will show the PPT with pictures and further show the concept using symbol (abstract).

The researchers emphasize the importance of creating a learning environment that enables students to engage with mathematical concepts through hands-on experiences. They argue that tangible and technology-assisted learning can help students make sense of abstract mathematical ideas and foster a deeper understanding of the subject. Therefore, the teacher will integrate real objects, pattern blocks, and PPT in teaching the concept (Fractions).

## 2.5 Benefits of Visual Images as a Strategy

Personalized learning adapts instruction to each student's specific needs. This can be in terms of delivery, pace, and content. It acknowledges that when it comes to education, there are rarely any absolutes. Students will learn in several ways and at various rates. They will have unique needs, and they will react differently to spoken, written, and visual information. Therefore, it is important for educators to use a variety of teaching methods and tools to cater to the diverse learning styles of their students. This will not only enhance their understanding and retention of the material but also promote a more inclusive and engaging learning environment.

The use of visual representations is a research-supported approach for aiding students in understanding and solving abstract mathematical problems. It serves as an indicator of a student's comprehension of the mathematical problem and a guide for them to correctly solve the problem. Visual representations support understanding complex mathematical concepts by providing tangible representations. However, those with learning challenges often avoid using these tools for problem-solving independently (Iris Center, 2022, p. 5). Therefore, to support students' mathematical development and problem-solving abilities throughout their education, teachers must continue to emphasize the use of visual images strategies. Giving students the chance to practice using visual aids independently can also help them learn mathematics concepts more confidently.

According to the study, students are six times more likely to solve math problems correctly when they use accurate visual representations than when they do

not use any visuals. But compared to students who do not use any visual representations at all, those who use inaccurate visuals are less likely to correctly solve mathematical problems (Boonen, Van Wesel, Jolles, & Van Der Schoot, 2014). This emphasizes the significance of not only employing visual images but also ensuring their accuracy. Students are more likely to complete word problems correctly if they use visual aids when solving them (Krawec, 2010, 2012). They can communicate their mathematical thinking and reasoning more effectively by using visual aids. Creating precise visual representations or using them strategically to solve problems is frequently difficult for students with learning disabilities (LD). However, studies showed students with learning disabilities have experienced significant progress in mathematics learning because of being taught how to comprehensively use a visual representation to solve word problems (Garderen, Scheuermann, & Poch, 2014).

Some students, however, may struggle to comprehend mathematical ideas and concepts by relying solely on visual aids. Students who have trouble comprehending mathematics frequently need various kinds of visual representations known as manipulatives (Iris Center, 2022, p. 5). Manipulatives are physical objects that students can move and touch to help them understand mathematical concepts.

Manipulatives could be an abacus, coins, pattern blocks, and other tools that let students physically experience and see the mathematics concepts they are working with. Students can gain a conceptual understanding of mathematical ideas with the aid of manipulatives.

To ensure students' success in higher education and beyond, educators must focus on their mathematical foundation. Creative teaching tactics, customized attention, and a welcoming learning atmosphere can all be beneficial. According to Jones (2019), the use of manipulatives in the classroom improves learning experiences for all students, bridges the gap between the physical and abstract, and promotes lifelong learning in young kids. Manipulatives can assist students of all grades and abilities. Golafshani (2013) argues that teachers can select manipulatives based on the topics they are teaching as well as how best to use them. To help students better

understand better mathematical ideas and foster creativity, teachers can also give them the chance to make their own manipulatives. Additionally, this method can encourage students to take responsibility for their education and increase classroom engagement.

#### 2.6 Related Theories

Learning theories help teachers develop more comprehensive learning strategies and adapt teaching styles to meet diverse learners, creating an inclusive and equitable learning environment. There are various learning theories that teachers adopt in their classrooms and, depending on each student's individual needs, each theory may be equally beneficial.

## 2.6.1 Jerome Bruner's Constructivist Theory of Learning and Cognitive Development

Like many other cognitive psychologists, Bruner emphasizes the role of existing knowledge structure in guiding learning and views the learner as an active agent. According to Bruner's (1996) theory, intellectual development typically occurs in three stages: enactive, iconic, and symbolic, in that order. Bruner did not assert that these stages were necessarily dependent on age or invariant, in contrast to Piaget's stages. His theory holds that at any age one can learn the fundamental principles of any subject if the information is presented in a way suitable for the student.

Jerome Bruner's constructivist theory of learning and cognitive development aligns well with the use of visual pictures in the classroom to teach mathematics. Visuals, such as diagrams, graphs, and geometric figures, manipulatives, can help students make sense of abstract topics and build meaningful connections while teaching mathematics. They give a tangible illustration of how learners actively develop information by building on prior knowledge and experiences. Visual pictures may be effective instruments in this process since they stimulate students' senses and improve their cognitive processes. Additionally, visual images can cater to different learning styles, allowing students to grasp mathematical concepts through visual

representation rather than relying solely on verbal or written explanations. This can enhance comprehension and retention of the material, as well as foster a deeper understanding of mathematical principles. By incorporating visual pictures into the classroom, teachers can create a more engaging and interactive learning environment that promotes active participation and critical thinking in mathematics education. Thus, Bruner's three stages of representations are as follows.

#### 1) Enactive representation (action-based)

Enactive mode of representation is used in the first year of life, where knowledge is stored in motor responses and thinking is based on physical actions. Adults can also perform motor tasks that are difficult to describe in symbolic form. Researchers will provide real objects to learn concepts (fraction) to strengthen the formation of abstract concepts in later stage.

#### 2) Iconic representation (image-based)

Visual aids and hands-on activities can help students develop problemsolving skills and understand abstract concepts. The researcher will use manipulatives and PPT to teach the fraction and provide opportunities for students to apply their knowledge in real-world scenarios.

## 3) Symbolic representation (language-based)

Symbolic development is important for mathematical and linguistic development, as it allows students to communicate and manipulate ideas beyond concrete objects or images. Knowledge is stored in other symbol systems, and symbols are not limited by actions or visuals. The pupil should have minimal trouble finishing at this stage. Symbolic development is a crucial skill for problem-solving and critical thinking in various fields such as science, technology, engineering, and mathematics. It also helps students to understand abstract concepts and develop higher order thinking skills.

#### 2.6.2 Experiential Learning Theory

The experiential learning idea is based on learning by doing. Experiential learning is based on the premise that having experiences is the best way to learn. These memories are retained in the brain and assist with fact recall and information retention. Experiential learning theory suggests that learners are more likely to remember and apply what they have learned when they actively participate in the learning process, rather than just passively receiving information. This approach emphasizes the importance of reflection and feedback to enhance the learning experience. Since the researcher focuses on teaching using concrete objects, the learners will interact with real objects and manipulatives (pattern blocks) to learn the concepts of fraction by relating to the enactive stage of Bruner's Learning theory.

The idea of this study fits well with Kolb's experiential learning cycle (see Figure 2.4), which is widely accepted as an effective model for learning. This model assumes that there are four phases in the learning process, which students ideally all go through. The first phase is the phase of concrete experience. The researcher will use everyday objects and manipulatives (pattern blocks), where the students practice learning the concepts of fraction. The second phase concerns the phase of reflective observation, which happens when the students actively participate in learning the concepts through different activities assigned by the researcher. In the third phase, abstract conceptualization takes place. This is done when the children learn to illustrate and represent the concepts of fractions symbolically. The fourth phase is the phase of active experimentation, in which students apply what they have learned in real life contexts. This will happen as children practice the concepts and are asked to share the various contexts in which they apply what they have learned. During this phase, teachers should encourage students to reflect on their experiences and provide feedback to help them improve their understanding. This will help students develop a deeper understanding of the concepts and how they can be applied in different situations.

## Kolb's Cycle of Experiential Learning

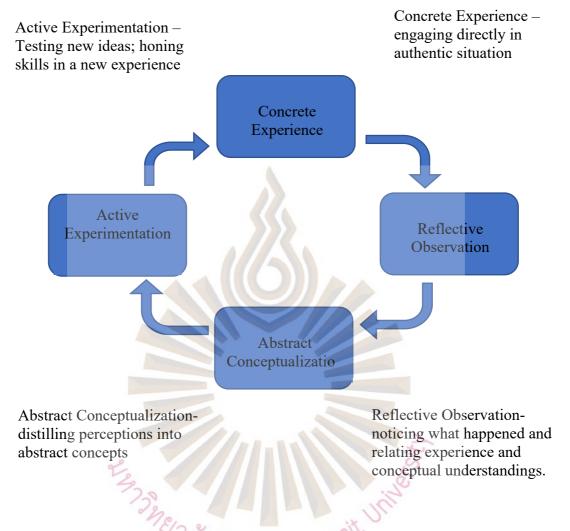


Figure 2.4 Illustration of Experiential Learning Source: Boston University, n.d.

#### 2.6.3 Theory of Multiple Intelligence

According to Gardner's Theory of Multiple Intelligence (MI), each person has the capacity to process information in seven largely independent ways, with each person showing a different type of intelligence. The Multiple Intelligences Theory (MIT) claimed that each person differs from the other in terms of the degree possessed in each intelligence. It attempted to explain how people process, learn, and remember information in seven ways (later, the eighth and ninth intelligences were added). The

verbal-linguistic, logical-mathematical, visual-spatial, bodily-kinesthetic, musical, intrapersonal, naturalistic, and existential intelligences are among them. When teachers are aware of their students' "diverse intelligences," they can create learning environments that are appropriate for each individual student (Maftoon & Sarem, 2012, p. 1234, as cited in Mehiri, 2020).

Gardner's MIT, according to Abdi and Rostami (2012), is applicable to every school and family because it encourages more creativity and places an emphasis on understanding along with the application of new information and concepts to improve the delivery of lessons. No matter what subject you teach—"the arts, sciences, history, or math," according to Gardner (2013)—you should provide learning materials in a variety of formats. Gardner continues by saying that anything you have a strong familiarity with, "There are numerous ways to convey and describe. Therefore, it is important for teachers to continuously explore and incorporate diverse teaching strategies and materials in their lessons to ensure that all students can understand and retain the information being taught. This approach also helps to create a more inclusive and engaging learning environment for students with different learning styles and abilities. Since the strategy incorporates various types of visuals and images to meet the needs of learners, the researcher is interested to find out the impact of learning achievement after using them.

One of the eight intelligences, visual-spatial intelligence, will also be practiced and used by the students as fraction concepts are taught using real objects, manipulatives (pattern blocks), and PPT. The ability to perceive, analyze, and comprehend visual information as well as to represent that information accurately and abstractly in one's mind is referred to as visual-spatial intelligence. Logical-mathematical intelligence, which requires the ability to relate to both abstract and real-world situations, is another intelligence that students will practice while being taught using visual images.

#### 2.7 Related Research

The study conducted by Mehmet et al. (2020) disclosed that the learning environment with concrete learning tools was more effective on mathematics achievement than the environment without such tools, while the environment using technology-assisted learning tools had a similar effect. These findings suggest that incorporating both concrete and technology-assisted learning tools in the classroom can be beneficial for students' mathematics achievement. Educators should consider utilizing a combination of these approaches to enhance student learning outcomes.

Boaler, Chen, Williams, and Cordero (2016) collaborated with a neuroscientist and mathematics educators to share amazing new evidence from brain science demonstrating the vitality and significance of visual thinking. Their research suggests that our brains are made up of "distributed networks" and that when we handle information, various parts of the brain light up and interact with one another. The mental processing of mathematical information is supported by two visual cortexes, the ventral and dorsal visual cortexes. Mathematical tasks involve the dorsal visual cortex, especially when students think about spatial or visual representations of quantity. Mathematical concepts are stored in visual and sensory-motor memories, demonstrating the importance of the visual cortex and connections between various brain pathways for embodied cognition. The fact that we make gestures demonstrates how deeply our motor and perceptual areas of the brain hold mathematical concepts. According to their study, we gesture because we physically and visually perceive, experience, and remember mathematics.

Using a visual learning approach, Raiyn (2016) introduces a novel idea to improve students' analytical thinking abilities. A teacher, a student, and a learning process make up the strategy's three basic building blocks. It encourages the presentation of data using visual tools like pictures, flowcharts, diagrams, and interactive simulations. An analysis of the students' performance revealed that using visual learning tools improved their Higher Order Thinking (HOT) skills. This approach can be particularly beneficial for students who struggle with traditional

lecture-based learning and can improve their engagement and retention of information. The visual learning strategy can also be easily adapted to various subjects and levels of education.

Studies in mathematics education suggest that using manipulatives is effective as it increases students' conceptual knowledge and is beneficial as it creates a positive attitude towards learning mathematics. However, its effectiveness depends on teachers' practice. Puchner, Taylor, O'Donnell, and Fick (2008) argued that manipulatives should be included in teachers' training and professional development. The authors argued that the issue was the pedagogical choices concerning teaching particular content, that is, how to teach (and learn) content with a manipulative.

Barbosa and Vale (2021) researched to examine pre-service teachers' problem-solving processes before and after taking a problem-solving module that emphasizes visual methods for problems with multiple solutions in the domain of rational numbers. In the context of rational numbers, this article discusses the significance of visualizations in problem-solving. This research was done with 14 pre-service elementary teachers in a pedagogical experience, utilizing a qualitative and interpretative approach to certify them to teach mathematics and science in grades 1-6. This study discovered that, because of their prior experiences as students, pre-service teachers felt more comfortable applying analytical strategies to multiple-solution problems involving rational numbers; however, they also used visual methods to solve non-routine problems or explain numerical manipulation. Regardless of their preference for analytical strategies, some teachers acknowledged the significance of alternative solutions and that teaching students how to read and interpret visual data can help them develop critical thinking skills and identify patterns and relationships.

Jamtsho (2019) carried out research using mixed methodologies to analyze grade six Bhutanese learners' academic achievement and perceptions towards the use of games incorporating manipulatives to teach geometry. The study included 28 mixed-ability students from two sixth-grade sections at one of the lower secondary schools in the Trashi Yangtse district of eastern Bhutan. To reduce shortcomings and

strengthen the research outcome, the researcher used both qualitative and quantitative instruments. The study provided two key conclusions. The first conclusion drawn from this research was that manipulative-based games improved the geometry learning achievement of Bhutanese students in grade 6, with most students scoring higher on the posttest than on the pretest. This resulted from the student's active participation in the learning process. The second finding indicates that due to a responsive and inclusive classroom environment and the use of various instructional games and mathematics manipulatives, the learners had a positive attitude toward the use of games incorporating manipulatives. The study highlights the importance of incorporating interactive and hands-on activities in the classroom to promote active engagement and positive attitudes toward learning.

Choden (2021) conducted a research study on the learning achievement and perception of grade 4 Bhutanese students toward the integration of manipulatives and cooperative learning. The study included 34 students in grade 4 from one of the middle secondary schools in the Monggar district of eastern Bhutan. Test score analysis and semi-structured interview thematic analysis were used to analyze the qualitative data, while paired sample t-tests were used to study the quantitative data. The findings revealed that using cooperative learning and manipulatives together in mathematics improved student learning as they could collaborate with friends, share ideas, and ask questions. This implies that incorporating these techniques into lessons helped students learn mathematics more effectively. Furthermore, the study suggests that instructors integrate cooperative learning and manipulatives into their lesson plans to improve their students' mathematical understanding a.

#### **CHAPTER 3**

#### RESEARCH METHODOLOGY

The general procedures used to conduct the study are described in this chapter. It covers the research design, the study's population and sample, the data collection tools used, the instrument validity and reliability, and the data analysis process. Additionally, ethical considerations and potential limitations of the study were discussed in this chapter to ensure the validity and credibility of the research findings. The aim was to provide a comprehensive understanding of the methodology used in conducting the study.

## 3.1 Research Design

The researcher has decided to find the impacts of using visual images by having one sample group to collect the data, the appropriate research design followed is quasi-experimental design. A quasi-experimental design, according to Thomas (2022), tries to establish a cause-and-effect link between an independent and dependent variable. It is common for researchers to study pre-existing groups that were subjected to various treatments beforehand, without the need for control groups.

To determine the impact of learning achievement and learning satisfaction following the use of visual images to teach the concepts of fractions, the researcher in this study employed mixed methodology, incorporating both aspects of qualitative and quantitative approaches. According to Buchholtz (2019), study is considered a mixed method when both qualitative and quantitative research are used. As per Timans, Wooters, and Heilbron (2019), a mixed method research design is one that gathers, analyzes, and "mixes" quantitative and qualitative research methods for a single study. The mixed research method, which combines quantitative and qualitative research

approaches, is used to investigate gaps in literature that cannot be addressed by a single method, claim Sahin and Ozturk (2019). Taherdoost (2022) also defines Mixed methods as techniques that simply utilize a combination of qualitative and quantitative approaches dependent on the objective of the study and the nature of the research question to create a deeper knowledge of the subject. Mixed-method techniques have gained popularity in recent years as they offer a more comprehensive understanding of complex phenomena and can help researchers to overcome the limitations of using a single approach. Figure 3.1 shows the research design of the study.

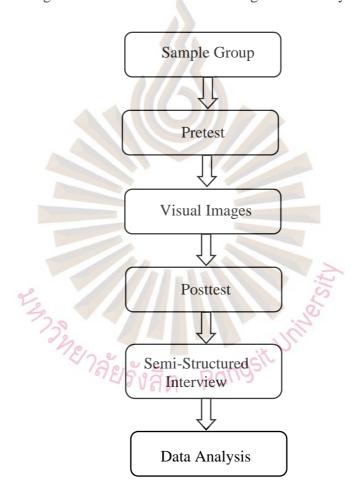


Figure 3.1 Research design of the study

## 3.2 Population and Sample of the Research

62 students in grade 4 from one of the middle secondary schools in the Chhukha district of western Bhutan was the study's population. Though there were two sections of grade 4, the researcher considered one section of 31 students using a clustered random sampling as a research participant to have the best result. They were between the ages of 9 and 11. Table 3.1 presents the numerical data of the research participants in terms of gender and age.

Table 3.1 Demographic profile of the research participants

| Gender        | Male | Female | Total |
|---------------|------|--------|-------|
| Number of the | 14   | 17     | 31    |
| students      |      |        |       |
| Age group     | 9-11 | 9-11   |       |

#### 3.3 Research Instruments

The researcher used qualitative and quantitative information to assess the data. The qualitative data provided a deeper understanding of the students' perceptions and experiences, while the quantitative data allowed for statistical analysis and generalization of findings. Combining these sources of information with the lesson plans provided a comprehensive view of the effectiveness of the teaching approach. The key instruments used for data collection were lesson plans, achievement test (pretest and posttest), and semi-structured interview.

#### 3.3.1 Lesson Plans

The researcher had prepared four lesson plans of 90 minutes (1 lesson plan = 2 sessions) each, to teach mathematics to grade 4 Bhutanese students on the topic "Fractions". The topic was further divided into 4 sub-topics and taught over four weeks.

With two sessions every week, a total of eight sessions were conducted. All the lessons were planned, integrating visual images such as real objects, manipulatives (pattern blocks), and PowerPoint presentations, to teach the research participants.

#### 3.3.2 Quantitative Data Collection Instrument

Pre-test and Post-test

Based on the requirement of Bhutanese Education framework established by royal Education (REC) and Bhutan Council of School Examination (BCSE), which adheres to oom's Taxonomy, the researcher framed 5 Multiple Choice Questions (MCQ) of 10 marks, 5 marks true or false questions, and 5 marks short answer questions on the topic fraction. A test of learning achievement was conducted before and after the intervention to compare the students' learning achievement. Both a pretest and posttest were included. The same set of students sat for the pretest before receiving intervention, and a posttest was conducted with same questions after providing the intervention (refer appendix D).

## 3.3.3 Qualitative Instruments

Semi-structured Interview

A semi-structured interview is a qualitative research approach that is used to acquire an in-depth knowledge of a respondent's sentiments and views about a given issue (Heath, 2023). Hence, to find out the students' satisfaction towards the use of visual images in learning mathematics, each student had face-to-face interview with the researcher after the intervention of the approach. The interview consisted of 5 questions which the researcher had framed. Each student got approximately 7-10 minutes to respond and were given the freedom to speak in the language of their choice (English or Dzongkha, national language of Bhutan). The responses of each student were audio recorded during the interview. Later the researcher translated and transcribed in English. The data was then analyzed using thematic analysis technique.

## 3.4 Validity and Reliability of the Study

#### 3.4.1 Content Validity

Instruments were validated by two experienced mathematics teachers from Bhutan and a professor from one of the universities in Thailand. The item Objective Congruence (IOC) of the instruments were calculated to see whether the items were aligned with the learning objectives. The criteria for validating IOC index ranges from -1 to +1 as described below:

- +1 indicated that the items are in congruent with the research objectives.
- 0 indicated that it is unclear or unsure whether the items are congruent with the research objectives.
  - -1 is a sign of items being irrelevant to the objectives.

IOC was calculated by applying the formula: IOC  $\sum = \frac{r}{n}$ , where 'r' is the score of individual experts' ratings and 'n' is the number of experts. The value of test items between 0.67 and 1.00 was considered accurate and acceptable. On the other hand, the value below 0.67 indicated that the items needed to be rephrased as per the experts' suggestions and feedback.

All the instruments used in this study were validated and given expert ratings above 0.67, which showed that the items were appropriate for the study. Lesson plans and test questions for learning achievement received an IOC rating of +1. (See Appendix C for Validity Report by Experts for Lesson Plan and Appendix E for Validity Report by Experts for Learning Achievement Test). The rating for the semi-structured questions was +1, which was higher than 0.67. (See Appendix G for the Validity Report by Experts).

#### 3.4.2 Reliability

Middleton (2023) defines reliability as the consistency with which a measurement procedure produces results. The measurement is considered reliable if

the same result can be produced consistently by using the same procedures under the same conditions. To check the reliability of the achievement test, the researcher conducted pilot test consisting of 20 marks multiple choice questions, with a section (30 students) of grade 5 students from one the school in Chhukha district, Bhutan. Kuder- Richardson formula (KR-20) was applied to find out the reliability coefficient of the learning outcome test. The KR-20 coefficient should be equal to or greater than 0.70 for the instruments to be reliable.

A pilot test was conducted to one section of grade 5 in the same school of research selected randomly by the school administration. The class consisted of 30 students and the questions were the same as the learning achievement test questions of grade 4 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 'Fractions'. 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 5, the coefficient obtained was 0.71 (see Appendix H for the Reliability Test Report). This indicated that the coefficient 0.71 for the instruments was greater than 0.70, which revealed that the test items were reliable.

## 3.5 Data Collection Procedure

#### 3.5.1 Ethical Consideration

#### 3.5.1.1 Approval

The researcher requested permission from Rangsit University's research and development institute. Before the start of data collection, the researcher received consent from the Ministry of Education in Bhutan, the Principal, and the related subject teacher at the study school. Because research participants were under the legal age, the parent of each study participant was required read and understand the content of the consent letter before signing it to reduce research participants' rights violations

throughout the study.

#### 3.5.1.2 Anonymity of the Participants

Over the course of the study, participant information, opinions, and interview records remained private and anonymous. To protect anonymity, the study's participants were not identified by name; instead, numbers were utilized (Example: A401, A402, A403). The pupils were also made aware of this before the research.

### 3.6 Data Analysis

To analyze the data the following two points were considered:

- 1) The analysis of test scores to find the impact of using visual images on learning achievement in mathematics.
- 2) Content analysis of interview to find the student's satisfaction toward the use of visual images in mathematics.

#### 3.6.1 Analysis for learning achievement

Pretest and posttest were given to students before and after the use of visual images in the teaching of mathematics to assess their degree of learning achievement. The paired sample t-test was used to analyze the learning accomplishment scores from the pretest and posttest using the appropriate software application. Based on the mean, standard deviation, and significant value, a comparison was made.

#### 3.6.2 Analysis for learning satisfaction

As the study used a combination of methodologies, semi-structured interviews were conducted to gain a better understanding of the students' satisfaction after utilizing visual images to learn mathematics. After establishing themes and patterns through coding, utilizing the thematic analysis approach, the data collected through semi-structured interviews were evaluated.

#### **CHAPTER 4**

#### **RESULT AND DATA ANALYSIS**

In this chapter, the researcher highlights the findings of the study on 'The Impacts of Using Visual Images in Teaching Mathematics to Grade 4 Bhutanese Students'. To determine the impacts of using visual images in learning the concepts of fraction, data were gathered by conducting pretest and posttest before and after teaching the concepts of fraction using visual images. The researcher also conducted semi-structured interviews with the same sample group to find out how satisfied they were with their learning using visual images.

The researcher presents the test results as numbers, which are quantitative data, and the information gathered from the interviews as descriptions and quotes, which are qualitative data.

## 4.1 Quantitative Data Analysis

To determine the level of learning after using visual images as learning interventions in mathematics, quantitative data were gathered by pretest and posttest. The pretest and posttest, which were given to 31 grade 4 Bhutanese students before and after the intervention in mathematics, had 20 different questions: 5 multiple choice questions, 5 true/false questions, and 5 short answer questions. To assess the efficacy of using visual images in a Bhutanese classroom, the research participants' pretest and posttest scores were compared using a paired sample t-test. Based on the mean, standard deviation, and significance level (P-Value).

## 4.1.1 Data Analysis of the Pretest and Posttest

The data collected from the pretest and posttest scores were analyzed to compare the learning achievements of the Grade 4 Bhutanese students before and after using visual images as described in Table 4.1.

Table 4.1 Comparison of Pretest and Posttest

| Student code | Pretest Score | Posttest Score | Improvement<br>Score | Improvement Percentage |  |
|--------------|---------------|----------------|----------------------|------------------------|--|
| A401         | 1.0           | 15.0           | 14.0                 | 70 %                   |  |
| A402         | 4.0           | 11.0           | 7.0                  | 35 %                   |  |
| A403         | 6.0           | 10.0           | 4.0                  | 20 %                   |  |
| A404         | 2.0           | 10.5           | 8.5                  | 42.5 %                 |  |
| A405         | 6.0           | 12.0           | 6.0                  | 30 %                   |  |
| A406         | 5.0           | 14.0           | 9.0                  | 45 %                   |  |
| A407         | 8.0           | 18.0           | 10.0                 | 50 %                   |  |
| A408         | 6.0           | 14.0           | 8.0                  | 40 %                   |  |
| A409         | 5.0           | 12.5           | 7.5                  | 37.5 %                 |  |
| A410         | 11.5          | 17.0           | 5.5                  | 27.5 %                 |  |
| A411         | 4.0           | 10.5           | 6.5                  | 32.5 %                 |  |
| A412         | 3.072         | 11.5           | 8.5                  | 42.5 %                 |  |
| A413         | 9.5           | VA 14.0        | 4.5                  | 22.5 %                 |  |
| A414         | 4.5           | 8.0            | 2.5                  | 12.5 %                 |  |
| A415         | 6.0           | 12.0           | 6.0                  | 30 %                   |  |
| A416         | 2.5           | 8.0            | 5.5                  | 27.5 %                 |  |
| A417         | 8.0           | 14.5           | 6.5                  | 32.5 %                 |  |
| A418         | 7.0           | 15.5           | 8.5                  | 42.5 %                 |  |
| A419         | 1.5           | 10.0           | 8.5                  | 42.5 %                 |  |
| A420         | 12.0          | 14.0           | 2.0                  | 10 %                   |  |
| A421         | 9.0           | 11.5           | 2.5                  | 12.5 %                 |  |
| A422         | 9.0           | 19.0           | 10.0                 | 50 %                   |  |

Table 4.1 Comparison of Pretest and Posttest (Cont.)

| Student code | Pretest Score | Posttest Score | Improvement Score | Improvement Percentage |  |
|--------------|---------------|----------------|-------------------|------------------------|--|
| A423         | 6.0           | 10.0           | 4.0               | 22.5 %                 |  |
| A424         | 2.0           | 6.0            | 4.0               | 20 %                   |  |
| A425         | 9.0           | 12.5           | 3.5               | 17.5 %                 |  |
| A426         | 5.0           | 10.0           | 5.0               | 25 %                   |  |
| A427         | 2.0           | 20.0           | 18.0              | 90 %                   |  |
| A428         | 7.0           | 14.0           | 7.0               | 35 %                   |  |
| A429         | 10.0          | 20.0           | 10.0              | 50 %                   |  |
| A430         | 8.0           | 12.0           | 4.0               | 20 %                   |  |
| A431         | 5.0           | 10.0           | 5.0               | 25 %                   |  |
| Mean         | 5.95          | 12.81          | 6.86              | 34.3 %                 |  |

Table 4.1 serves two purposes: it complements the descriptive statistical analysis results and gives a clear view of how each student's scores improved in the posttest compared to the pretest. The student with the greatest improvement was A427, who scored 18 marks higher in the posttest than the pretest showing the highest improvement percentage as 90%, achieved by 1 student. Student A420 showed the lowest improvement, scoring only 2 marks higher in the posttest than the pretest with the improvement percentage of 10 %. It is important to note that all students were able to increase their scores in the posttest compared to the pretest.

Table 4.2 Paired Sample T – Test Analysis

| Group                                     | Pre-Test |       | Posttest |       | Mean<br>Differences | t       | P. Value |
|---|----------|-------|----------|-------|---------------------|---------|----------|
|   | Mean     | SD    | Mean     | SD    |                     |         |          |
| Sample                                    | 5.95     | 2.967 | 12.81    | 3.463 | 12.81- 5.95         | - 11.38 | 0.000    |
| Group                                     | 3.93     | 2.907 | 12.01    | 3.403 | 6.86                |         |          |
| Significance level (p): <0.05-significant |          |       |          |       |                     |         |          |

Table 4.2 shows the result of the descriptive statistical analysis for the sample group's achievement test scores. The mean score for the pretest and the posttest were 5.95 and 12.81, respectively. It is evident from the results presented in Table 4.2 that the posttest mean score ( $\overline{\mathbf{X}}$  =12.81) of the group was higher than that of the pretest mean score ( $\overline{\mathbf{X}}$  =5.95) with a mean difference of 6.86. The greater mean score in the posttest indicated the efficiency and effectiveness of using visual images. A paired sample t-test shown in Table 4.2 indicated the significance value of .01, indicating the test's significance. The standard deviation of the pretest and posttest were 2.97 and 3.46 as shown in Table 4.2.

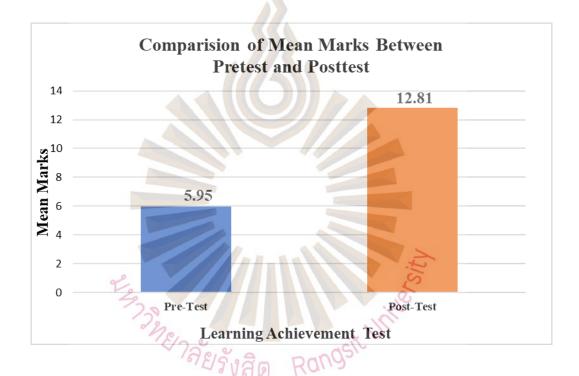


Figure 4.1 Pretest and Posttest Mean Comparison

The mean scores after the intervention were much higher than the scores before the intervention. This shows that the participants' learning achievement before the intervention was significantly lower than after the intervention. Figure 4.2 clearly shows that the average score after the intervention is higher than the average score before the intervention. Overall, these results indicate that using visual images helped grade 4 Bhutanese students to improve their math learning outcomes. Therefore, we can say that the first research question has been answered positively, and the first research objective and hypothesis have been supported.

## 4.2 Qualitative Data Analysis

The qualitative data was collected through semi-structured interview to further respond to the second objective of the study. The second objective of the study was to investigate whether teaching mathematics using visual images like Real Objects, Manipulatives & PPT would increase students' learning satisfaction or not. To investigate, the researcher conducted interviews with all the students in the sample group after completing teaching. To keep the privacy of the research participants, the researcher used the same student code used during pretest and posttest during the interview. The students could speak in the language they felt comfortable sharing their opinions on the study. During the interviews, we recorded everything the students said, and later, we translated and transcribed their responses into English. This allowed us to analyze the data and draw meaningful conclusions about how the visual images influenced and satisfied their learning experiences.

The data were read, analyzed, and interpreted into themes based on the research objectives and questions of the study. The data from the students' interviews are analyzed under five themes: 1) Past Experiences 2) Interesting and Fun, 3) Understanding Concepts, 4) Facilitated Learning Satisfaction and 5) self-confidence. Most students gave a positive response in using visual images in learning mathematics.

# 4.2.1 Past Experiences 7 7 Rangs

Many students said that this intervention provided them with a unique way of learning. In most math classes, teachers used chalk and a chalkboard to teach lessons, and then students would do work on their own. As a result, the students did not fully understand the material and often just copied the answers without really understanding them. The intervention introduced a more interactive and engaging approach to learning mathematics. Instead of relying solely on traditional methods, students were encouraged to actively participate in discussions and problem-solving activities. This not only fostered a deeper understanding of the subject but also promoted critical thinking skills and independent learning.

"Our teacher mostly uses chalk and chalkboard to teach and give questions to solve ourselves." (A405, personal communication, June 14, 2023).

"Our teacher used to give us materials in groups, so we had less opportunity to play with them, but I believe that when we have the objects individually to handle, we understand better." (A411, personal communication, June 14, 2023).

"We have rarely seen different visual images that can be related to one specific concept, which helps us to understand better and remember for a longer time." (A401, personal communication, June 14, 2023).

"For the first time, I witnessed a teacher teaching math by incorporating videos and various pictures with PPT. I had a great time experiencing the new strategy." (A422, personal communication, June 15, 2023).

#### 4.2.2 Interesting and Fun

Students in the classroom had fun and thoroughly enjoyed their math lessons when real objects, pattern blocks, and various images in PowerPoint presentations were incorporated into the learning process. By using real objects, students could touch and play with math ideas, making them easier to understand. They had so much fun exploring the concepts of fraction with pattern blocks and using their creativity and problem-solving skills to solve the problems. Additionally, the pictures in the PowerPoint presentations caught students' attention and helped them visualize abstract mathematical concepts more easily. These exciting ways of learning not only helped students understand math better but also made the whole class enjoyable and memorable learning atmosphere.

"Especially getting to play with pattern blocks individually made the learning interesting and fun. We understood the concepts much better, and we enjoyed a lot." (A415, personal communication, June 14, 2023).

"Simultaneously looking at the pictures and exploring the concepts with pattern blocks made me to solve the problems easily, thus I felt happy being able to solve the problems independently." (A428, personal communication, June 15, 2023).

"Using pattern blocks individually was most interesting and it motivated me to learn mathematics. We are using pattern blocks to learn the concepts of fraction for the first time." (A417, personal communication, June 14, 2023).

"The lesson was interesting when teacher showed examples in PPT, videos and in different forms of picture." (A430, personal communication, June 15, 2023).

Thus, it is evident from the quotes that using various visual images to teach mathematics to students was enjoyable. Additionally, concepts are better understood when the lesson is presented in a fun way.

#### **4.2.3 Understanding Concepts**

Visual images significantly improved learners' understanding of abstract concepts, particularly fractions. Pattern blocks, real objects, and PowerPoint presentations are effective tools for this purpose. Pattern blocks allow learners to understand the concepts of fraction by observing how different pieces fit together to form a whole, while real objects, like shoes, fruits, and pizzas, provide tangible demonstrations of fractions. PPT presentations offer visual aids, diagrams, and step-by-step illustrations, engaging learners' attention, simplifying complex ideas, and facilitating a deeper comprehension of fractional relationships. Overall, visual images like pattern blocks, real objects, and PPT presentations effectively engage and support learners in understanding fraction concepts.

Most of the students admitted that seeing different visual images helped them to better understand the concepts. Below are the statements that students provided during the interview.

"I was able to understand the topics very well by using the pattern blocks individually, and using real objects like shoes and fruits helped me to understand the concepts thoroughly." (A420, personal communication, June 15, 2023).

"I learned better when I got to play with the objects (learning by doing)." (A407, personal communication, June 14, 2023).

"Particularly using pattern blocks and real objects helped me to understand better and I could remember for the longer time." (A423, personal communication, June 15, 2023).

"As I have problem in hearing clearly, I could understand the concepts of fraction easily by playing with pattern blocks and seeing the different pictures." (A419, personal communication, June 14, 2023).

"I knew how one fraction is smaller/greater than other fraction by drawing pictures." (A426, personal communication, June 15, 2023).

According to the students' opinions, they could particularly understand better when they were given access to different visual images. As a result, teaching using visual images helped them to easily understand and Mretain for the longer period.

#### **4.2.4 Facilitated Learning Satisfaction**

Visual images, such as objects, pattern blocks, and PowerPoint presentations, significantly enhanced learning satisfaction in understanding fractions. These tools provided students with real-world examples, making abstract concepts more relatable. Pattern blocks allowed students to experiment with combining and contrasting shapes to create fractions. Visual diagrams and interactive elements were incorporated into PowerPoint presentations to engage students and improve their understanding of fractions. This approach facilitates comprehension, retention, and results in greater

learning satisfaction. The following are some of the opinions of the participants.

"When we got to touch the things, we understand easily. Teacher showing different pictures helped us to understand the concepts more easily." (A408, personal communication, June 14, 2023).

"When teacher taught us using real object, I came to know that fractions are used in our daily life." (A413, personal communication, June 14, 2023).

"I think I can understand better, if the teacher uses the visual images to teach other topics as well, then I will enjoy learning mathematics." (A427, personal communication, June 15, 2023).

"When the teacher taught equivalent fractions by showing Pizza videos, I understood easily and remembered for a longer period of time." (A404, personal communication, June 14, 2023).

#### 4.2.5 Self Confidence

The use of visual images in teaching fraction has significantly boosted students' confidence. By providing a visual and concrete representation, visual images helped learners better understand and relate to abstract fraction concepts. Learners can better understand fractions' operation and relationship to practical situations by seeing fractions visually represented in diagrams, charts, or manipulatives. As they successfully interacted with visual images and comprehended fraction concepts, learners experienced a sense of accomplishment that increased their self-confidence in their mathematical abilities. Their increased self-confidence helped them learn fractions successfully, but it also carried over to other mathematical concepts and cultivates a positive attitude toward mathematics in general.

"I was sure in my answers because I used pattern blocks while solving the problems." (A416, personal communication, June 14, 2023).

"I was able to understand better and more easily by playing with pattern blocks and having the teacher explain using different pictures." (A424, personal communication, June 15, 2023).

"Our math teacher used to teach us using chalk and a chalkboard, but when madam taught us using different objects and pictures, it was interesting, and I believe I can perform better in mathematics." (A421, personal communication, June 15, 2023).

It is clear from the responses given above that they enjoyed learning mathematics with various visual representations. Many of the students experienced new learning environments that were enjoyable and fascinating. Additionally, it was discovered that they could easily understand the concepts and retain them for a longer period. Students' confidence was further increased by being able to apply the concepts in real-world situations. Moreover, the students first encountered learning math through PPT that included videos and other types of images, which promotes positive satisfaction in learning mathematics.

Thus, the researcher concluded that using visual images (real objects, pattern blocks, and PPT) when teaching mathematics has not only improved learning achievement but also had positive impact on students' learning satisfaction, which has a direct relationship to the growth of students' overall academic performance.

#### **CHAPTER 5**

## CONCLUSION, DISCUSSION AND RECOMMENDATIONS

This chapter covers the study's conclusions, which were reported in Chapter 4. It is followed by discussions of the findings and recommendations for future studies and research to enhance the learning process in mathematics instruction.

#### 5.1 Conclusion

The questions below served as a reminder of the primary purpose of the research and helped to contextualize the subsequent analysis.

- 1) Would there be any impacts on grade 4 Bhutanese students' learning achievement in Mathematics after using visual images?
- 2) Would there be learning satisfaction after using visual images in teaching and learning mathematics?

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

#### **5.1.1** The Result of Test Score Analysis

To answer the initial research questions, the researcher used the results of the pretest and posttest. This study's initial inquiry was whether using visual images would have any impacts on grade 4 Bhutanese students' learning achievement in fractions. To find the learning achievement of the students before and after using visual images (real objects, pattern blocks, and PPT) in teaching fractions to grade 4 Bhutanese students, pretest and posttest were conducted with the research participants on the same items.

(Appendix H contains a sample learning outcome test.)

To compare the levels of achievement between the pretest and posttest, a paired sample t-test was used in a comparative statistical analysis within the sample group. The mean score on the pretest was 5.95, and the mean score on the posttest was 12.81, with a mean difference of 6.86. The students performed better in the posttest than the pretest, as evidenced by the difference in the mean score. The analysis revealed that the mean score of the posttest was higher than the pretest's as shown in Table 4.1 in Chapter 4. It also shows that the significance value(p) was .01, showing that there was a statistically significant improvement in the posttest scores over the pretest scores. Therefore, the initial question of this research was answered as the learning achievement of grade 4 Bhutanese learners in fraction were yielded better when taught with the use of different visual images.

As a result, the study found that using visual images as an intervention improved students' learning achievement in the posttest compared to the pretest. The first study hypothesis, which stated that using images will improve learners' learning achievement, was examined and shown to be true.

## 5.1.2 The Result of Semi-Structured Interviews

Investigating grade 4 Bhutanese students' satisfaction with their learning after using visual images as a learning strategy to understand fractional concepts was the second research question. To address the second research question, the researcher conducted semi-structured interviews with individual students. The collected data was analyzed using thematic analysis, and it became clear that students responded favorably, showing that they could comprehend concepts of fractions more easily and retain them for a longer period after having used a variety of visual images. Due to their unique opportunity to play with the objects during the teaching and learning session, the students were engaged with full excitement. The interview gave the students the opportunity to discuss their learning experiences in lessons that used visual images. The data collected from their semi-structured interview responses were

reviewed by the researcher based on five themes: 1) Past Experiences 2) interesting and fun 3) understanding concepts 4) Facilitated learning satisfaction and 5) Self-confidence.

Individual participants responded that all the lessons taught were interesting as learners were exposed to diverse kinds of visual images and learnt through hands-on experience during the activities. Their interest in experiencing pattern blocks individually has further boosted them to participate actively in learning mathematics using visual images. Learners were active throughout the lessons and were able to solve problems relating to different visual images. Many participants mentioned that they understood the concepts of fraction better when they got many opportunities to experience the pattern blocks individually. Incorporating real objects as one of the tools had also helped them to relate the concepts to real-life situations and further boosted students' confidence in learning mathematics. Overall, the various visual images kept students motivated because they had the chance to put concepts into practice through practical application, which improved understanding and helped people retain the information longer.

The findings also showed that using visual images for teaching and learning mathematics was a new thing for them and it has a positive impact on their learning as the use of visual images enhanced students' learning in mathematics. Most of them shared, learning mathematics with visual images helped them learn the subject better and their desire to learn other topics too. It also helped them to remember and recollect the lesson in a brief period. As a result, they understood the mathematical concepts better and could perform well in the subject.

Therefore, the data compiled from semi-structured interview, the researcher is confident in concluding that using visual images has satisfied the grade 4 Bhutanese students in learning mathematics. Hence, it provided an answer to the second research question.

#### **5.2 Discussion**

The study aimed to study the effectiveness of using visual images in learning concepts of fraction to grade 4 Bhutanese students' learning achievement. It also investigated their learning satisfaction towards this strategy. The findings showed that visual images (real objects, pattern blocks and PPT) was effective in teaching and learning mathematics for Grade 4 Bhutanese students, and it exhibited positive learning satisfaction. These findings are presented in detail to answer the research questions proposed in the study.

#### 5.2.1 Students' Learning Achievement

According to the study, using visual images helped Bhutanese students in grade 4 to learn mathematics more effectively. The learning achievement test results revealed a significant mean difference of 6.86 between the sample group's pretest and posttest scores. With a significant p-value of .01, using visual images helped most students perform better on the posttest than on the pretest. The gap between high and low achievers was reduced as even the low achievers raised their scores. These results show how effectively visual images improved students' mathematical learning achievement. Furthermore, the results indicated that the use of visual images had a positive impact on students' understanding and retention of mathematical concepts. This suggests that incorporating visual images into teaching strategies can be an effective method.

According to an analysis of students' learning achievement data, it was found that all the students performed better after the use of different visual images. This was in relation to the study carried out by Witzel et al., (2001). Their findings indicated that students can more easily access mathematical knowledge when they understand how to illustrate and manipulate abstract concepts using common objects. Additionally, the study of Mehmet et al. (2020) also disclosed that the learning environment with concrete learning tools was more effective on mathematics achievement than the environment without such tools, while the environment using

technology-assisted learning tools had a similar effect.

Upon the interview, one of the students who has difficulty in hearing clearly responded that he enjoyed and understood the concepts easily by getting to play and experience the pattern blocks individually. The finding aligns with the study conducted by Moyar (2021), where he revealed that visual learning is especially advantageous for people who have a visual learning style, which means they comprehend information better when it is presented visually rather than verbally or in writing. This finding is further supported by the study conducted by Dayame (2019), he produced the findings that when the students undergo intervention there are great possibilities to improve the students' performance in terms of conceptualizing fraction using manipulative and visual models.

Nevertheless, in the review of the thesis about how visual images helped Grade 4 Bhutanese students perform better in math, some interesting things came up. First, there were students who performed well on the pretest but did not significantly improve with visual images. This makes us to ponder whether the visuals helped them. On the other hand, some students performed poorly on the pretest but significantly improved when they employed visual images. This suggests that visual images could make a big difference for these students. It is therefore difficult to determine if using visual aids when teaching mathematics has always been beneficial. We need to understand how each student was different and how visual images could help them. According to Bodovski and Farkas (2007), teachers should concentrate on improving both the starting knowledge and academic engagement of students in the lowest-performing group in order to minimize disparity in mathematical success.

However, improved posttest scores could be attributed to the use of different visual images in the mathematics classroom, which improved students' retention of the concept learned. This is consistent with the findings of Shabiralyani et al. (2015), where he stated that visual images can enhance students' learning experiences and make the classroom environment more engaging, helping them retain information better and improving their academic performance. Therefore, the study had further

proven that using visual images can improve the learning achievement of students in mathematics.

#### 5.2.2 Students' Learning Satisfaction

The study's second key finding was that students showed positive learning satisfaction toward the use of visual images in learning mathematics. The use of visual images in mathematics instruction and learning was viewed as exciting, enjoyable, and joyful. It was discovered that it inspired and increased the participants' confidence in the topic. Providing the students with the set of pattern blocks individually and relating them to different illustrations helped the students understand the abstract concepts and retain the lesson. Furthermore, the responses concluded that they experienced a new environment in learning through PPT that included videos and other related illustrations to fraction concepts.

One prominent factor identified was utilization of pattern blocks as individual learning tools. As per interview It was observed that the tool had significantly contributed to the objective of learning satisfaction of the study. Thus, well-designed instructional materials and activities that align with learners' needs and preferences contributed to higher levels of learning satisfaction. This finding supports the notion that learner-centered approaches, such as personalized learning and differentiated instruction, can enhance learners' sense of satisfaction and engagement. In parallel to this, Iris center (2022, p. 5) stated that students who have trouble comprehending mathematics frequently need various kinds of visual representations known as manipulatives. This was further supported by Jones (2019), that the use of manipulatives in the classroom improves learning experiences for all the students, bridges the gap between physical and abstract, and promotes lifelong learning in young kids.

Furthermore, using PPT with pictures and videos emerged as a crucial factor influencing learning satisfaction. According to the findings, most of the students were exposed for the first time to the use of PPT for learning mathematics. Learners who

actively participated in discussions, group work, and hands-on activities were more satisfied than those who sat in traditional, lecture-based settings. These findings emphasize the importance of encouraging interactive and engaging teaching practices to foster positive learning experiences. This finding is like the study conducted by Lari (2014) that PowerPoint is a versatile tool that can be used to teach mathematics to primary students in an engaging and interactive way.

Similarly, using visual images assisted learners in easily understanding concepts, relating concepts to real-life situations, and remembering the lesson in general. National Council of Teachers of Mathematics (2000) stated the use of real objects in mathematics education can help to make abstract concepts more concrete and accessible for students, as well as provide opportunities for the real-world application of mathematical concepts. Moreover, one of the purposes of the National School Curriculum (NSC) in Bhutan is based on the principles of competency-based education (CBE), which emphasizes the application of skills and knowledge in real-world situation and learner centered.

As a result, all the positive findings about the impacts of using visual images in mathematics teaching were attributed to students having the opportunity to experience various visual images. Another reason for positive learning satisfaction with the use of visual images could be the use of relevant and reliable PPT with various pictures during the lesson. Throughout the learning process, the students were found to be curious, actively involved, and motivated. With all the participants expressing positive opinions, the researcher concluded that using visual images in teaching and learning mathematics to Grade 4 Bhutanese students had a significant impact.

#### 5.3 Recommendations

Based on the findings and insights gathered from the research conducted on the impacts of using visual images in teaching mathematics, a set of practical recommendations will be presented. These recommendations aim to guide educators and future researcher in effectively integrating visual images into their mathematics

instruction, with the goal of improving student learning outcomes, enhancing mathematical understanding, and fostering a positive attitude towards the subject.

#### **5.3.1 Recommendations for Practice**

- 1) The teaching of mathematics for the topic Fraction using visual images have been influential on students' learning achievement. The findings of this study revealed that the posttest's learning accomplishment was higher than the pretest. As a result, visual images in regular classroom instruction are strongly advised.
- 2) The use of visual images is not restricted to mathematics only but can be appropriate in any other subjects like English, Dzongkha, Social Studies, Science, and ICT. However, the teacher should be wise to plan as per the requirement of the lesson and relevant content.
- 3) Teachers can incorporate the use of visual images in mathematics while teaching other topics to make their lessons more interesting and engaging, which improves students' learning achievement. Visual images can help students to better understand abstract mathematical concepts by providing concrete representations. Additionally, incorporating visual images can also cater to different learning styles and enhance students' overall comprehension and retention of the material.

#### **5.3.2** Recommendation for Future Study

To carry out further research in this field, the researcher would like to recommend the future researchers as follows:

- 1) The Study was limited to a section of 31 Grade 4 Bhutanese Students. Similar studies could be conducted with different grade levels, larger sample size, and longer duration to strengthen the findings.
- 2) The study was carried out using only pattern blocks as one of the Manipulatives. Future researcher could make use of more manipulatives.

- 3) The study considered the concepts of fraction to be taught using visual images strategy. Future researchers could use the strategy with other topics to see the effectiveness of the strategy.
- 4) The study focused on just three types of visual images (real objects, pattern blocks & PPT), other types could be explored for more effective learning.
- 5) The research was only carried out for one month. Future researchers might Conduct the study over a longer time to strengthen its findings.

To summarize, using different visual images is an excellent teaching strategy that is very much needed in today's schools, particularly for teaching and studying mathematics. If teachers incorporate visual images in their classrooms, students will do better on assessments and retain the concepts taught. It will also assist students in comprehending abstract subjects in an engaging and exciting way. As a result, one of the critical techniques to improving students' learning success and satisfaction will be the usage of visual images as one of the strategies in teaching and learning mathematics.

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# APPENDIX A EXPERTS WHO VALIDATED THE RESEARCH INSTRUMENT

### Detail of three expertise who validated the instruments

### Three Experts are:

| Sl.No. | Name                | Qualification/<br>Position Title | Institute   |
|--------|---------------------|----------------------------------|---|
| 1      | Dr. Gary Torremucha | Associate Professor              | Rangsit English Language Institute (RELI); Rangsit University |
| 2      | Mrs. Pema Selden    | M.Ed., Teacher                   | Phuentsholing Primary School                                  |
| 3      | Mrs. Lhap Gyem      | M.Ed., Teacher                   | Dewathang Primary school                                      |

### Instruments

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

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

To

The Graduate School

Rangsit University

Thailand

I, Gary Torremucha, a professor of Rangsit English Language Institute, Rangsit University, hereby give my consent to the researcher Mrs. Kinzang Lhaden (6407667), a student of Master in Curriculum and Instruction, Suryadhep Teachers College, Rangsit University to disclose my name as a research Instrument validator in her thesis paper titled "The Impacts of Using Visual Images for Mathematics Achievement of Grade 4 Bhutanese Students. I respect the terms and regulations of the Graduate School; thus, I also give my consent to the Graduate School, Rangsit University to contact me in case of any clarification regarding my consent.

Gary Torremucha

Signature

Date 25 September 2023

Par Rangsit University of Rangsit University

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

To

The Graduate School

Rangsit University

Thailand

I, Pema Seldon, a teacher of Phuentsholing Primary School, hereby give my consent to the researcher Mrs. Kinzang Lhaden (6407667), a student of Master in Curriculum and Instruction, Suryadhep Teachers College, Rangsit University to disclose my name as a research Instrument validator in her thesis paper titled "The Impacts of Using Visual Images for Mathematics Achievement of Grade 4 Bhutanese Students". I respect the terms and regulations of the Graduate School; thus, I also give my consent to the Graduate School, Rangsit University to contact me in case of any clarification regarding my consent.

Pema Seldon

Signature

Date: 25 September 2023

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

To

The Graduate School

Rangsit University

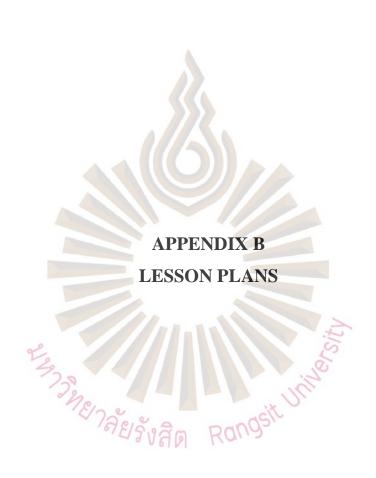
Thailand

I, Lhap Gyem, a teacher of Dewathang Primary School, hereby give my consent to the researcher Mrs. Kinzang Lhaden (6407667), a student of Master in Curriculum and Instruction, Suryadhep Teachers College, Rangsit University to disclose my name as a research Instrument validator in her thesis paper titled "The Impacts of Using Visual Images for Mathematics Achievement of Grade 4 Bhutanese Students". I respect the terms and regulations of the Graduate School; thus, I also give my consent to the Graduate School, Rangsit University to contact me in case of any clarification regarding my consent.

Lhap Gyem

Date: 25 September 2023

LANDARIA Rangsit University



### Lesson Plan 1 (Session 1 & 2)

Class: IV Subject: Math

**Topic:** Fractions Time: 90 minutes

**Teaching Learning Materials:** worksheets

Previous Knowledge: Whole and part

**Structure:** PPT and Manipulatives (pattern blocks)

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

• Write the word meaning of 'fraction' with illustration after free play with real object.

- Model three types of fractions using pattern blocks after teacher's information input through PowerPoint presentation.
- Represent three types of fractions in pictorial form in their notebook after having discussed the correct modelling of the fraction.
- Write the meaning of all the fractions correctly after being practiced modelling the using pattern blocks.

### **Lesson Description:**

• This lesson helps students develop visual images for fractions, mixed numbers, improper fraction, and proper fraction through concrete materials. For this lesson, students have prior knowledge of the whole and part. The teacher conducts a brief activity as an introduction using real objects before navigating to the actual lesson. After that, the teacher introduces some inputs on the current topic through PPT presentation, and simultaneously, the teacher demonstrates the topic. Finally, students are assigned to complete some activities using manipulatives (pattern blocks) as a free play to check the understanding of the concept of all three types of fractions, and they are assigned some problems as extended learning activity on print out worksheet.

### **General Instruction: (3 mins)**

• Today, during these two periods, we will try to refresh our memories of what a fraction means using actual objects. You will practice using pattern blocks in groups after I use a PowerPoint presentation to

demonstrate some examples of different types of fractions. Afterwards, you should be able to use any appropriate images to represent all types of fractions. Then finally you should be able to write the meaning of all types of fractions individually.

### **Checking Instruction:** (1 min)

 Ask one volunteer to repeat the instruction to make sure that all students are on track.

### **Lesson Introduction (6 mins)**

• Students are provided with divided fruit parts in a group and ask them to make a complete fruit.



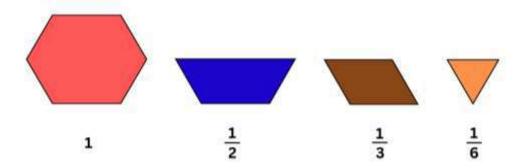
Allow them to tell what they can notice from their experiment.

**Exposition:** (40 mins): Teacher writes different forms of numbers as below.

- (a) 8 (b)  $1\frac{1}{3}$  (c)  $\frac{7}{3}$  (d)  $\frac{4}{6}$
- Ask the following questions to whole class
- i) What do you notice from the numbers written on the chalkboard?
- ii) Are the same? Teacher to whole class interaction.

**Instruction:** To understand these different fractions, I will show the PPT presentation. So, everybody watches and listens carefully. You can ask questions inbetween if you do not understand.

Note: teacher will also explain the relationship between pattern blocks as below.



- Explain the concepts through PPT presentation.

### Activity 1(20 mins):

**Direction:** To do this activity I will provide pattern blocks in a group; you should use pattern blocks to represent three types of fractions. When you complete your modelling using pattern blocks, say bingo, I will come and check your work then let you write the pictorial representation in your notebook.

**Monitoring:** Teacher will walk around and observe the interaction and if necessary, guide them by probing questions.

Follow up (10 mins): Teacher will ask to write the generalization of three different fractions in their notebook with an example.

**Closure (10 mins):** Teachers will give away the printed work sheet to further practice the concept taught, as an extended learning activity.

### Lesson Plan 2 (Session 3 & 4)

Class: IV Subject: Math

**Topic:** Renaming Fractions **Time:** 90 minutes

**Teaching Learning Materials:** worksheets

**Previous Knowledge:** Whole and part and types of fractions

**Structure:** PPT and Manipulatives (pattern blocks)

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

• Relate the fraction with the real-life situation.

Write two importance of fractions in our daily lives.

 Name two or more fractions having different names with the same value

### **Lesson Description:**

• This lesson helps students to contextualize the fraction with day-to-day activities. It also navigates the students through some of the significance of fractions in our daily lives. The teacher conducts a short activity before the lesson starts followed by the delivery of the teacher's input. This lesson helps students investigate fractions using concrete materials and name some different fractions with the same values. For this lesson, students have prior knowledge of basic proper fractions. The teacher conducts a brief activity before navigating to the actual lesson. Finally, the teacher provides an online link through which the learners explore and extend their knowledge on the topic.

### **Lesson Introduction (10 mins)**

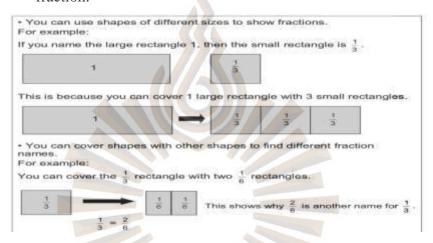
• To recapitulate the previous lesson, teacher will ask a few volunteers to represent the picture in fraction



- Then the teacher will write  $\frac{2}{3}$  on the board and discuss with the whole class how to relate to our daily activities.
- Together we should be able to generalize that, we can use in cooking, probability, money, etc.
- Then state the outline of the lesson to be taught.

### **Exposition: (30 mins)**

• The teacher will draw the pictures on the board below to rename the fraction.



• Then the teacher will show the PPT to explain and with some more examples.

### Activity 1(20 mins):

**Direction:** To do this activity i will provide pattern blocks in group: you should explore

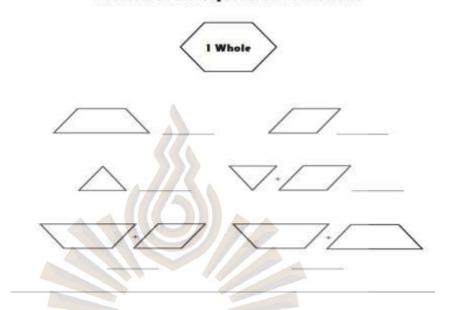
how you can rename fraction using pattern blocks. When you complete your modelling using pattern blocks, say bingo, I will come and check your work then

let you write the pictorial representation in your notebook.

**Monitoring:** Teacher will walk around and observe the interaction and if necessary guide them by probing questions.

**Follow-up (15 mins):** To check their understanding the teacher will provide the worksheet as below.

### Pattern Block Equivalent Fractions



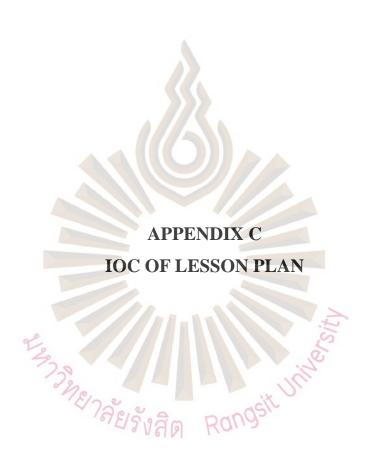
**Closer (15 mins):** Teacher will explain and give away the printed worksheet to further practice the concept taught as an extended learning activity as below:

Q. Show the following equations using Pattern Blocks.

$$\frac{1}{6} + \frac{1}{3} = \frac{3}{6} \text{ or } \frac{1}{2} = \frac{5}{6}$$

$$\frac{1}{6} + \frac{2}{3} = \frac{5}{6}$$

$$\frac{4}{6} - \frac{1}{3} = \frac{2}{6}$$



### IOC FOR LESSON PLAN BY THE EXPERTS

| Sl.No              | Attributes    | Expert 1 | Expert 2 | Expert 3 | Average | Congruence |
|--------------------|---------------|----------|----------|----------|---------|------------|
| 1                  | Lesson plan 1 | +1       | +1       | +1       | +1      | Congruent  |
| 2                  | Lesson plan 2 | +1       | +1       | +1       | +1      | Congruent  |
| 3                  | Lesson plan 3 | +1       | +1       | +1       | +1      | Congruent  |
| 4                  | Lesson plan 4 | +1       | +1       | +1       | +1      | Congruent  |
| Overall Average +1 |               |          |          |          |         | Congruent  |



# APPENDIX D LEARNING ACHIEVEMENT TEST

### **Learning Achievement Test**

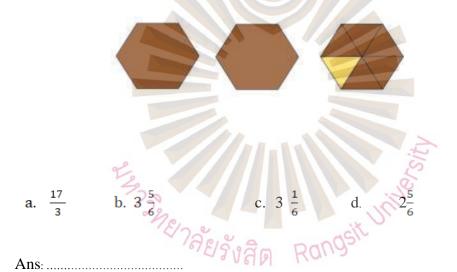
Class: 4 Subject: Mathematics

Topic: Fractions Total: 20 marks

### Part A

**Direction:** Each statement is followed by four answers. Choose the most correct answer and write it in the space provided. (2 x 5=10 marks)

1) The shaded parts of the diagram given below represents:



2) Which pair of fractions are equivalent?

A  $\frac{2}{3}$  and  $\frac{4}{6}$ 

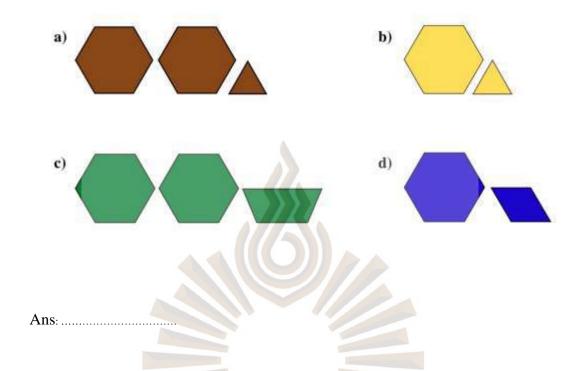
B  $\frac{3}{5}$  and  $\frac{8}{10}$ 

C  $\frac{1}{3}$  and  $\frac{1}{2}$ 

D  $2\frac{1}{5}$  and  $\frac{1}{5}$ 

Ans: .....

3) Which of the diagram represents the fraction  $\frac{13}{6}$ 



4) Kelzang is comparing two fractions. What number should he write in the box to fit comparisons rule?



a) 2

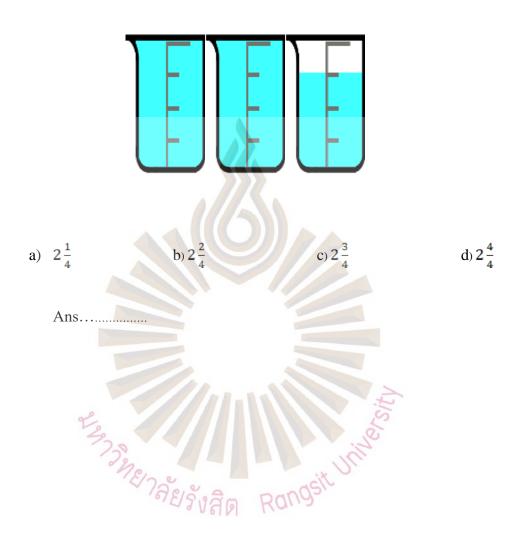
b) 3

C) 4

**d**) 5

Ans: ...

5) Namgay stood first in beaker filling race during the sports day. The picture below represents the fraction of beakers filled. What fraction of beakers did Namgay fill?



### Part B

**Direction**: Write **True** if statement is correct and **False** if the statement is incorrect in the space provided against the statement. (1 x 5=5 marks)

| Sl. No | Statement  | True/False |
|--------|--|------------|
| 1      | $\frac{3}{7} < \frac{3}{5}$  |            |
| 2      | $1 \text{ whole} = \frac{3}{8}$  |            |
| 3      | Fractions can be compared when they referred to same   |            |
|        | whole  |            |
| 4      | Par a strain Rangsit University of Rangsity O |            |
| 5      | Multiply the numerator and denominator by the  |            |
|        | different number to create an equivalent fraction.   |            |

### **Section C: Short answer**

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

Q1. Sonam ate  $\frac{2}{3}$  of a pizza. Pema ate  $\frac{2}{5}$  of a pizza. Who ate more pizza? Draw a Picture to show your answer is correct.

**Q2.** Draw any appropriate shapes to represent that  $\frac{6}{8}$  and  $\frac{3}{4}$  are equivalent. [1 mark]

**Q3.** Create a picture using pattern blocks to show  $\frac{1}{6} = \frac{1}{3} = \frac{1}{2}$  [2 marks]

### **Test Blueprint**

| Content  | Remembering | Understanding | Applying | Analyzing | Evaluating | Creating | Total |
|----------|-------------|---------------|----------|-----------|------------|----------|-------|
| Fraction | Q1A         | Q4B           | Q3A      | Q2B       | Q2A        | Q3C      | 20    |
|          | (2),        | (1)           | (2)      | (1)       | (2)        | (2)      |       |
|          |             | Q4A           | Q2C      | Q3B       | Q1C        |          |       |
|          |             | (2),          | (1)      | (1)       | (2)        |          |       |
|          |             | Q5A           | Q1B      |           |            |          |       |
|          |             | (2)           | (1)      |           |            |          |       |
|          |             |               | Q5B      |           |            |          |       |
|          |             |               | (1)      |           |            |          |       |
|          | 2           | 5             | 5        | 2         | 4          | 2        | 20    |

# APPENDIX E IOC FOR LEARNING ACHIEVEMENT TEST



## IOC FOR LEARNING ACHIEVEMENT TEST QUESTIONS BY THE EXPERTS

| Sl.No.    | ITEM<br>TEST NO. | Expert 1 | Expert 2 | Expert 3 | Average | Congruence |  |  |
|-----------|------------------|----------|----------|----------|---------|------------|--|--|
|           | SECTION A        |          |          |          |         |            |  |  |
| 1         | Question 1       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 2         | Question 2       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 3         | Question 3       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 4         | Question 4       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 5         | Question 5       | +1       | +1       | +1       | +1      | Congruent  |  |  |
|           |                  |          | Section  | В        |         |            |  |  |
| 6         | Question 1       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 7         | Question 2       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 8         | Question 3       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 9         | Question 4       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 10        | Question 5       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| Section C |                  |          |          |          |         |            |  |  |
| 11        | Question 1       | +1       | +1       | +1       | +1      | Congruent  |  |  |
| 12        | Question 2       | 75/2     | +1       | +1       | +1      | Congruent  |  |  |
| 13        | Question 3       | ARIS     | ්බ් R    | angplu   | +1      | Congruent  |  |  |
| Overa     | Overall Average  |          | 1        |          |         | Congruent  |  |  |

# APPENDIX F SEMI-STRUCTURED INTERVIEW QUESTIONS



# SEMI-STRUCTURED QUESTIONS

| Sl. No | Semi-Structured Interview Questions   |
|--------|---|
| 1      | You describe how you usually learn Mathematics?   |
| 2      | How did you feel about learning Fractions using Visual images?                              |
| 3      | Do you think the use of visual images will help you learn Fractions better? Why or why not? |
| 4      | What did you like most about the lesson? Why?   |
| 5      | Would you prefer to learn other topics using visual images? Why?                            |

Adapted from Rinzin, 2021



# APPENDIX G IOC FOR SEMI-STRUCTURED QUESTIONS



### IOC FOR SEMI-STRUCTUREDQUESTIONS BY EXPERTS

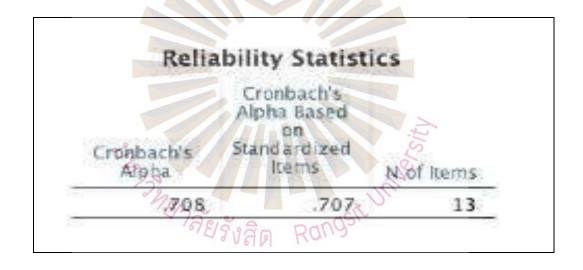
| Sl.NO           | Items                    | Expert 1 | Expert 2 | Expert 3 | Average | Congruence |
|-----------------|--------------------------|----------|----------|----------|---------|------------|
| 1               | Could you describe       | +1       | +1       | +1       | +1      | Congruent  |
|                 | how you usually learn    |          |          |          |         |            |
|                 | Mathematics?             |          |          |          |         |            |
| 2               | How did you feel about   | +1       | +1       | +1       | +1      | Congruent  |
|                 | learning Fractions       |          |          |          |         |            |
|                 | using Visual images?     |          |          |          |         |            |
| 3               | Do you think the use of  | +1       | +1       | +1       | +1      | Congruent  |
|                 | visual images will help  | 11/15    |          |          |         |            |
|                 | you learn Fractions      |          |          |          |         |            |
|                 | better? Why or why       |          |          |          |         |            |
|                 | not?                     |          |          |          |         |            |
| 4               | What did you like most   | +1       | +1       | +1       | +1      | Congruent  |
|                 | about the lesson? Why?   |          |          |          |         |            |
| 5               | Would you prefer to      | +1       | +1       | +1       | +1      | Congruent  |
|                 | learn other topics using | MIL      |          |          | 14      |            |
|                 | visual images? Why?      |          |          |          | 5/2     |            |
| Overall Average |                          |          | BAL      | +1 1017  |         | Congruent  |

คราลัยรังสิต Rangsit

# APPENDIX H RELIABILITY TEST SCORES OF LEARNING ACHIEVEMENT

#### **Reliability Test Scores of the Learning Achievement Test**

|      |           | N  | %     |
|------|-----------|----|-------|
| ases | Valid     | 30 | 100.0 |
|      | Excludeda | 0  | .0    |
|      | Total     | 30 | 100.0 |







Director General

Department of School Education

Ministry of Education

Thimphu, Bhutan

Date: April 30, 2023

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 May 3, 2023 to June 15, 2023. The details of the candidates are shown as follows:

| Sl.no | Name             | Research title   | Research School             |  |
|-------|------------------|--|-----------------------------|--|
| 1     | Nima Dorji       | ima Dorji  The use of mobile -essisted language learning (malf) through cake application to improve speaking skill of grade 6 FSL blutanese students |                             |  |
| 2     | Nima Tshering    | The integration of Field trip with Multimedia.  Technology in Social Studies of grade 4 18hutanese students.   | Trashigatshel PS,<br>Chukha |  |
| 3     | Kezang<br>Wangmo | The use of Task-Based learning Approach to enhance the speaking skill of grade 4 Hustanese Students.   | Rinchengang PS,<br>Chukha   |  |
| 4     | Jamyang Lhamo    | The Effectiveness of Audio Assisted Reading to<br>Enhance Reading Comprehension Skill for Grade<br>5 Bhatanese Students                              | Doonglagang<br>PS/Tsigang   |  |
| 5     | Kinzarig Lhaden  | The impacts of using visual images in teaching mathematics to grade 4 bhutanese students   | Wangelm MSS, Chukha         |  |

Thank you for your kind consideration.

Truly yours,

Mipapan Sakalings

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



## चेदाऱ्या ५८:द्रया ऋषा क्रींट तद्येया स्वता

# Ministry of Education & Skills Development Department of School Education School Liaison and Coordination Division



DSE/SLCD/SLCU(2.2)/2023/604

May 10, 2023

The Principals

Wangchu MSS, Trashi Gatshel PS, Rinchengang PS, Doonglagang PS

Subject: Approval to conduct a study and collect data

Dear Principals,

The following teachers are pursuing a Master of Education Program in Curriculum and Instruction at Suryadhep Teachers College in Rangsit University, Thailand. In partial fulfillment to complete the program successfully, they are required to conduct a research study on various topics related to education.

| Sl.No. | Name   | Research Title   | Research School               |  |
|--------|--|--|-------------------------------|--|
| 1      | Nima Dori  | The use of mobile-assisted language learning (mall) through cake application to improve speaking skill of grade 6 ESL Bhutanese students | Wangchu MSS,<br>Chhukha       |  |
| 2      | Nima Tshering  | The integration of Field trip with Multimedia Technology in Social Studies of grade 4 Bhutanese students.                                | Trashi Gatshel PS,<br>Chhukha |  |
| 3      | Kezang The use of Task-Based Learning Approach to enhance the speaking skill of grade 4 Bhutanese Students |  | Rinchengang PS,<br>Chhukha    |  |
| 4      | Jamyang<br>Lhamo   | The Effectiveness of Audio Assisted Reading to Enhance Reading Comprehension Skill for Grade 5 Bhutanese Students                        | Doonglagang PS.<br>Tsirang    |  |
| 5      | Kinzang Laden  | The impacts of using visual images in teaching mathematics to grade 4 Bhutanese students   | Wangchu MSS,<br>Chhukha       |  |

Therefore, you are requested to support and allow them to collect data from the schools, subject to the following conditions:

- 1. The study will not interfere with the regular academic activities of the school.
- The confidentiality and privacy of the participants will be strictly maintained, and the data collected will only be used for academic purposes.
- Any inconvenience caused to the school during the data collection process will be minimized.

(Karma Galay)

Director General

CC: 1) Director of Master of Education Program in Curriculum and Instruction, Suryadhep Teachers College.

2) Person concerned.



#### **Consent Letter**

#### **Parents' Consent Letter**

Dear Parents, 4

I am currently enrolled in the Master of Education in Curriculum and Instruction, at Rangsit University, Thailand. I am conducting a research study on the "The Impact of using Visual images in teaching Mathematics to grade 4 Bhutanese Students". This research requires student participation. The instruments involved during the study are pretest and posttest, and semi structured interview for obtaining the required data. Therefore, I would like to seek your permission to let your child participate in this study. Their names, identifications and schools will be kept confidential and anonymous.

I look forward to your cooperation in approving your child to participate in this research study.

Thanking you

Yours sincerely

**Kinzang Lhaden** 

**Student** 

| I acknowledge that I have read the letter provided by Mrs. Kinzang Lhaden and ha | ıve |
|--|-----|
| agreed to let my child () to participate in t                                    | the |
| research as described.   |     |

| Name: | Signature: |
|-------|------------|
| Date: |            |

Date: 08/05/2023

#### CONSENT LETTER

#### Respected sir

I am currently pursuing my Master of Education in Curriculum and Instruction at Rangait University, Thailand, I am conducting research on "The Impacts of Using Visual Images in Teaching Mathematics For Grade 4 Bhutanese Students". The main focus of this study is to investigate the impacts on learning achievement and students' satisfaction after using the visual images. I will be teaching on the topic Fraction from class IV Math textbook for a period of one month. During this period, a pretest will be conducted before the lessons are being delivered and a posttest and an interview after the implementation of the strategy using visual images.

Therefore, I would like to seek your prior consent to let grade 4 students take part in this research. I assure you that the information of the participants, such as their names, identities, and school will remain anonymous, and all the information will be kept confidential.

I look forward to your great support.

Thanking you.

Yours Sincerely.

Kinzang Lhaden Student

Chnukha

I give my consent to conduct the research with grade 4 students of my school. I confirm and acknowledge that I am being made clear about the content of the research and have read the letter provided by the researcher.

Subject Teacher/ Class Teacher



# **Paired Sample T-Test**

# **Paired Samples statistics**

|                | Mean N |    | Std. Deviation | Std. Error |  |
|----------------|--------|----|----------------|------------|--|
|                | Mean   | 11 | Sid. Deviation | Mean       |  |
| Pair 1 Pretest | 5.95   | 31 | 2.97           | 0.53       |  |
| 2 Posttest     | 12.81  | 31 | 3.46           | 0.62       |  |

# **Paired Samples Test**

|          | Paired Differences |                  |                      |                              |              |        |    |                 |
|----------|--------------------|------------------|----------------------|------------------------------|--------------|--------|----|-----------------|
|          | Mean               | Std<br>Deviation | Std<br>Error<br>Mean | Confid<br>Interval<br>Differ | dence of the | t t    | df | Sig. (2-tailed) |
| Pair     |                    | 'निधुनुं १       | สิต T                | saug <sub>e,</sub>           |              |        |    |                 |
| 1Pretest |                    |                  | 0101                 |                              |              |        |    |                 |
|          | -6.86              | 3.36             | 0.60                 | -8.09                        | -5.62        | -11.38 | 30 | .000            |
| Posttest |                    |                  |                      |                              |              |        |    |                 |

# APPENDIX L USE OF VISUAL IMAGES IN TEACHING MATHEMATICS











#### **BIOGRAPHY**

Name Kinzang Lhaden

Date of birth March 1, 1984

Place of birth Monggar, Bhutan

Education background National Institute of Education, Paro, Bhutan

Bachelor of Education, 2009

Rangsit University, Thailand

Master of Education in Curriculum

and Instruction, 2023

Scholarship Trongsa Penlop Scholarship (TPS)

Address Wangchhu MSS, Chukha, Bhutan

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