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

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ABSTRACT

The study aimed to investigate the effects of using visual images on the mathematics learning achievement and satisfaction of grade 4 Bhutanese students. It involved 31 participants from a middle secondary school and adopted a quasi-experimental design, employing both qualitative and quantitative methods. Lesson plans served as the interventional tools, while learning achievement tests and semi-structured interviews were used for data collection. Quantitative data were analyzed using paired sample t-tests, and qualitative data were analyzed using thematic analysis. The analysis of pretest and posttest scores revealed that the mean score of the posttest was greater than that of the pretest. Semi-structured interviews indicated that participants not only developed a positive attitude towards mathematics but also demonstrated motivation and satisfaction with the use of visual images in learning. Themes such as "Experience," "Engagement and Enjoyment," "Comprehension of Concepts," "Enhanced Learning Satisfaction," and "Self-Confidence" showed how students were encouraged to gain a deeper understanding of abstract and complex concepts. Therefore, the research outcomes would benefit educators and curriculum designers in enhancing students' comprehension and interest in learning mathematics.

Keywords: Visual Images Learning Achievement, Satisfaction, Mathematics, Fraction Lessons

INTRODUCTION

Mathematics is considered as an important branch of study amongst various disciplines of school curriculum particularly in this age of science and technology. Mathematics encourages and cultivates essential life skills, career preparation, financial literacy, and technology proficiency in learners. The Education system of Bhutan has prioritized mathematics as one of the compulsory subjects from elementary to higher secondary education. However, research has shown that the compulsory status of the subject has limited success in motivating students to pursue further education in mathematics (Dukpa, 2014).

In Bhutan, mathematics education has been steadily insufficient, leading to low assessment scores, resulting from traditional teaching methods that induce anxiety and negative attitudes towards the subject. Furthermore, based on data from the (Bhutan Council for School Examination and Assessment for the years 2018 and 2019, the average scores in mathematics were 60.26, representing the lowest mean compared to 64.69 in English and 73.66 in Dzongkha, the National language.

The transition from simpler pre-primary (PP-III) to complicated mathematics in grade 4 is a significant challenge for students in Bhutan due to cognitive demands and complex mathematical concepts. Students find it challenging to immediately adjust to the vast and overwhelming curriculum content from fourth to twelfth grade. Grade 4 introduces complex word problems that worsen the situation by demanding students to do arithmetic operations and interpret patterns, which makes it more difficult for them to transition smoothly from simpler mathematics (Dorji & Tshering, 2020). Students have trouble due to the sudden change in the mathematics curriculum, leading to unfavorable attitudes. During the 113th National Day in the year 2020, the King issued a historic Royal Decree on Education Reform, which served as a reminder of the pressing need to raise the standard of education in Bhutan (Wangchuk & Dendup, 2023). Therefore, among the numerous elements influencing educational quality, instructors' pedagogy plays a critical role in assuring excellent learning. According to Sherab & Dorji's research (2013), teachers' instructional techniques are of paramount importance, especially in the context of educational reforms in Bhutan. Effective teaching methods are crucial to enhancing the quality

of education in all subjects. In Bhutan, instructors are trained in child-centered techniques during pre-service programs, but there is a gap between these methods and their implementation in schools. As a result, instructors must have strong pedagogical experiences and competences to guarantee that the teaching and learning processes are both effective and engaging

Therefore, to address this challenge, it requires a shift towards incorporating diverse visual images in teaching and learning. Jalbani (2015) asserted that teachers might effectively engage their primary students by using visuals and auditory assistance. However, it was emphasized that the content and delivery methods needed to be well-crafted to provide maximum learning opportunities. Additionally, Rigzin (2021) revealed that with Bhutan's increasing embrace of technology and multimedia tools, the potential for enhancing mathematics education through visual means becomes even more exciting potentially transforming students' attitudes, motivation, and performance.

In this study, visual images refer to the use of real objects, 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.

Consequently, the researcher made the decision to investigate the effectiveness of visual images in learning mathematics, since this would certainly have impacts on students' learning achievement and satisfaction. Further, the findings from this study will provide teachers with an alternative effective strategy to enhance students' learning achievement and satisfaction.

RESEARCH OBJECTIVES

1. To study the mathematics learning achievement of grade 4 Bhutanese students before and after using visual images.

2. To investigate the satisfaction towards Math learning through visual images.

LITERATURE REVIEW

1. Mathematics Curriculum in Bhutan

Bhutan has shifted its educational approach to a global curriculum, aligning

with the REC's principles. The National School Curriculum focuses on the "how" and "why," equipping learners with 21st-century skills and transversal competencies, resulting from McLean and Hiddleston's progressive vision study (Ministry of Education of Bhutan, 2019).

The reform initiative aims to improve students' mathematical reasoning and problem-solving abilities by adopting a constructivist approach that emphasizes critical thinking, active student interactions, and lifelong learning (Tshewang, 2015). This consequently highlighted that successful methods for teaching fraction concepts are linked to the ideals of educational reform, which include critical thinking, a constructivist approach, active interactions, lifelong learning, and the development of mathematical reasoning. By putting these ideas into practice, students' comprehension of fractions can become more thorough and significant.

2. Visual Images as Strategy

This study explores the use of visual images, including real objects (fruits, shoes, and pizza), manipulatives (pattern blocks), and digital pictures, in PowerPoint presentations as pedagogical tools for the instruction of fractions. This approach combines both tangible and digital learning tools, providing students with a comprehensive and versatile learning experience. Kaitera & Harmoinen (2022) stated that this method provides a strong foundation for learning advanced mathematical concepts, allowing students to justify arguments using diverse approaches. The researcher emphasizes the use of real objects, visual images, and PowerPoint to teach fractions visually, bridging theoretical and procedural knowledge gaps. Additionally, the study conducted by Schwarz (2016) supports this strategy, stating that students need numerous opportunities to engage with different interpretations of fractions. The combination of visual images, real objects, and digital tools promotes independent thinking, creativity, and practical application of mathematical concepts, aligning with the National School Curriculum (NSC) of Bhutan and competency-based education (CBE) principles.

3. PowerPoint Presentation (PPT)

"Digital competence is a crucial competency in Bhutan's mathematics education, as it enhances students' technological literacy and confidence. This is crucial for the 21st-century workforce and enables access to online resources and tools" (REC, 2022, p. 4). This emphasis

on technological proficiency aligns with the findings of Rigzin & Chalermnirundorn (2021), who highlight that the integration of multimedia technology in mathematics education not only engages and benefits learners but also contributes to their motivation and self-confidence. Together, the promotion of digital competence and the use of multimedia technology form a cohesive approach to preparing students for the challenges, opportunities, and difficulties of the modern educational landscape. The study conducted by M. Nawale & Nawale (2022) shows that PowerPoint presentations effectively cater to auditory, visual, and kinesthetic learning styles. Visual learners benefit from slides, animations, videos, narration, and interactive components. The customizable nature enhances the learning experience, making PowerPoint an effective tool for diverse student populations.

While acknowledging PowerPoint's adaptability as a tool for teaching mathematics to primary students in an engaging and interactive manner (Lari, 2014), it is essential for educators to recognize the need for customization to align with students' individual needs and preferences. Customizing presentations ensures that the content is not only delivered effectively but also resonates with the diverse learning styles and preferences of students. By tailoring PowerPoint presentations, educators can optimize the use of this versatile tool to create a more personalized and impactful learning experience for primary students.

4. Use of Real Objects–Connection of Concepts to Real World

Real objects stand out as essential teaching tools in mathematics that help students make connection between abstract concepts and real-world applications, as emphasized by the National Council of Teachers of Mathematics (2000). This approach alignes seamlessly with Bhutan's National School Curriculum, emphasizing competency-based education principles that prioritize the practical application of skills in real-world contexts, making mathematics a relevant and integral part of students' daily live.

Whether using everyday items like pizza, Lego bricks, or cards to teach fractions or employing geometric shapes in everyday objects to enhance spatial reasoning and geometry skills, real objects effectively bridge the gap between abstract theories and relatable experiences. In lower-grade levels, the use of non-standard objects not only aids in teaching measurement and estimation but also fosters a deeper understanding

of mathematical concepts, as highlighted by Povey's study, (2013, as cited in Wuolle, 2016). The incorporation of physical objects in arithmetic teaching, as noted by Jones & Triller (2017), captures young minds' attention, resulting in improved knowledge retention and a more profound connection between mathematical concepts and real-world situations. Furthermore, the insights of researchers such as Piaget and Bruner have highlighted the importance of learners actively constructing knowledge through interactions with their environment, including physical objects (Mcleod, 2023). This holistic approach enhances the educational experience by integrating real-world applications, tangible objects, and cognitive engagement for a comprehensive understanding of mathematics.

5. Manipulatives (pattern blocks)

According to the research conducted by Jamtsho & Chalermnirundorn (2019), learners achieve a deeper understanding of complex mathematical concepts through hands-on tools and in-depth discussions, particularly when engaging with manipulatives to explore and solve challenging problems. This is consistent with the study's focus on using pattern blocks to help students explore fractions and their relationships. Similarly, assert that by utilizing common objects to represent abstract ideas, students can enhance their comprehension of fractions and their relationships. Choden (2021) finding further emphasizes the positive impact of manipulatives on students' learning, highlighting the collaborative and interactive aspects that facilitate improved understanding in mathematics.

Dayame (2019) expands on this idea, revealing that interventions utilizing manipulative and visual models can significantly enhance students' performance in conceptualizing fractions. Additionally, introducing various techniques, including representations, models, and manipulatives, proves effective in improving academic performance. This underscores the importance of incorporating diverse teaching methods in classrooms to accommodate different learning styles and enhance students' comprehension and retention of complex mathematical concepts. In summary, these studies collectively emphasize the effectiveness of hands-on tools, manipulatives, and diverse teaching methods in promoting a deeper understanding of mathematics concepts among students. The figure below illustrates how pattern blocks can be used to explore fractional concepts.

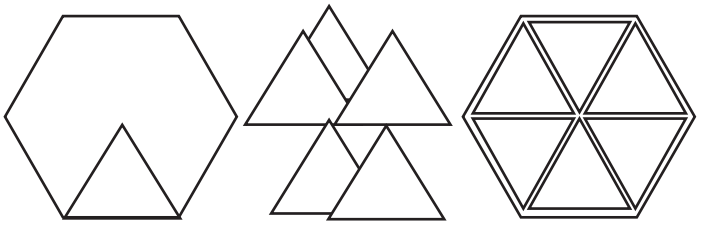

Figure 1 Pattern blocks showing fractional relationships

CONCEPTUAL FRAMEWORK

The study consisted of an independent variable, the use of visual images for mathematics achievement among grade 4 Bhutanese students, with the aim of enhancing the learning environment. Motivated by the desire to leverage cognitive benefits, accommodate diverse learning styles, foster conceptual clarity and engagement, the researcher aimed to measure two dependent variables: students' learning achievement and students' satisfaction. To gain a deeper knowledge of satisfaction, the researcher incorporated qualitative methods such as semi-structured interview, allowing for a thorough examination of students' satisfaction and broadening the overall study's insights into the impact of visual images on the learning experience. The framework is illustrated below:

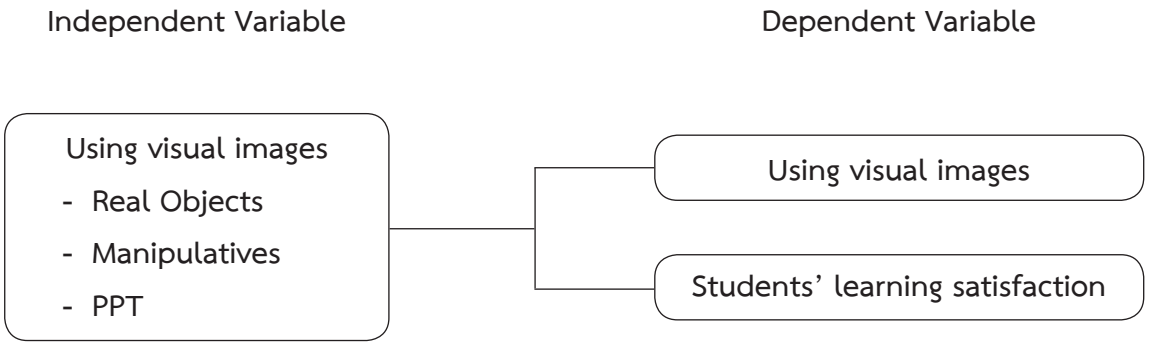

Figure 2 Independent and Dependent Variables for the study

RESEARCH METHODOLOGY

A mixed-methods approach was adopted in this study, which integrates both quantitative and qualitative research techniques. Prior to using visual images as a pedagogical tool, a pretest was administered, followed by a four-week instructional phase in which fraction concepts were taught using visual images. A posttest and semi-structured interview were conducted after the intervention to gather quantitative and qualitative data, respectively, to evaluate students' achievement and satisfaction towards learning through visual images. The primary objective of this study was to determine how the use of visual images influences the mathematical achievement of fourth-grade Bhutanese students, with an emphasis on improving their learning outcomes and overall satisfaction.

1. Population and Sample

To form a sample group for the study, a clustered random sampling method was employed by the researcher, involving 31 students aged 9 to 11 from a Middle secondary school in Chhukha Dzongkhag. The selected sample group exhibited a mix of abilities and gender. In alignment with the principles outlined by Kothari (2004), the concept of clustered random sampling was implemented. The researcher specifically chose one section, consisting of 31 students, from the two available sections in the fourth grade. This method involves dividing the population into clusters, randomly selecting certain clusters, and subsequently including all individuals within the chosen clusters in the study (Kothari, 2004).

2. Research Instruments

2.1 Lesson Plans

The researcher had prepared four lesson plans of 90 minutes (1 lesson plan = 2 sessions) to teach mathematics to grade 4 Bhutanese students on the topic "Fractions". The topic was 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, and visual images were integrated into each lesson plan such as real objects, manipulatives (pattern blocks), and PowerPoint presentations, to teach the research participants.

2.2 Pretest and Posttest

Based on the requirements of Bhutanese Education framework established by Royal Education Council (REC) and Bhutan Council of School Examination (BCSE) guidelines the researcher framed 5 Multiple Choice Questions (MCQ) of 10 marks, and to get rid of the weakness

of the work in the case of test difficulty and discrimination on the topic fraction 5 marks true or false questions, and 5 marks short answer questions were framed. The test items were validated by three experts and obtained IOC rating as +1, which is above 0.67. Therefore, rating showed that the test items were appropriate for the study. To assess the impact of the intervention on students' learning achievement, a test of learning achievement was administered both before and after the intervention, enabling a comparison of the students' learning achievement.

2.3 Semi-Structured Interview Form

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 (Barclay, 2018). All the 31 participants were interviewed face to face and were given the freedom to respond in the language of their choice (English or Dzongkha, national language of Bhutan) to receive the genuine responses towards the use of visual images in learning mathematics. The interview consisted of 5 questions that the researcher has framed, focusing particularly to gather comprehensive insights into various aspects of students' experiences with visual images in learning mathematics. The responses of each of them were recoded and later the researcher translated and transcribed into English

Therefore, by using the identical set of questions, the researcher was able to conduct standardized analyses and facilitate the easier development of themes.

3. Validity and Reliability

3.1 Validity

Item Objective Congruence (IOC) was used to determine the instrument's validity, which helped to determine whether the items were aligned with the research objectives. In this study all the instruments (lesson plans, learning achievement test, and semi-structured interview form) were validated by three experts and had rated +1 which was above 0.67, it showed that the items were appropriate for the study.

3.2 Reliability

A pilot test was conducted to grade 5 of same school with same set of questions. Assessing reliability at a higher level, researcher aims to account for potential variability in participant abilities and ensure that the test items can consistently produce reliable results across different levels of knowledge. This helps identify any weaknesses

or inconsistencies in the test items that might not be apparent when assessing reliability at the participants' level. 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, which indicated that test items were reliable.

4. Ethical Consideration

The researcher obtained permission from Rangsit University's research and development institute and secured consent from the Ministry of Education in Bhutan, the school's Principal, and the relevant subject teacher before commencing data collection. Since the research involved minors, parental consent was mandatory to protect the rights of participants. Anonymity was maintained by using identification numbers (e.g., A401, A402, A403) instead of names. The participants were also made aware of other relevant information appearances in particularly on this research.

Research Results

Analysis of achievement test scores

A comparative statistical analysis using paired sample t-test showed a mean difference of 6.86 between the pretest and posttest scores. The results of the analysis indicated that the mean score of the posttest was higher than the mean score of the pretest as displayed in table below.

Table 1 Paired T-Test Analysis

Sample Group	Pretest		Posttest		Mean Difference	t	P-Value
	$\bar{X}$	SD	$\bar{X}$	SD			
N = 31	5.95	2.967	12.81	3.463	6.86	-11.38	.01

According to Table 1, the pretest and posttest mean scores were 5.95 and 12.81, respectively. The data clearly showed that the mean score of the posttest was higher than the pretest score for the group being analyzed, with a mean difference of 6.68. This implies that utilizing visual images proved more effective, as is evident from the higher posttest mean score in comparison to the pretest score. The significant value (p) was .01, which also indicated that there was a significant improvement in scores.

The study discovered that using visual images in learning mathematics had a substantial positive impact on students' mathematical ability after assessing the scores. The maximum and the minimum scores in pretest were 12 and 1 respectively, whereas the maximum and minimum scores in the posttest were 20 and 6 respectively. Overall, these results indicated that after using visual images, the grade 4 Bhutanese students significantly improved their learning achievement in mathematics.

Semi-structured interview

The second objective of the study was to determine whether using visual images like real objects, manipulatives, and PowerPoint when teaching mathematics would result in students' satisfaction. After the instructional sessions had concluded, the researcher conducted interviews with the sample group of students to further find out their satisfaction. A thematic analysis of the data obtained from semi-structured interviews led to the identification of five main themes: 1) Past Experiences; 2) Engagement and Enjoyment; 3) Comprehension of Concepts; 4) Enhanced Learning Satisfaction; and 5) Self-confidence. A vast majority of students expressed favorable feedback regarding the use of visual images in their mathematics lessons.

1. Experience: In contrast to conventional chalk-and-board teaching methods, the intervention introduced a new and engaging approach to learning mathematics. The shift from classroom instruction to individualized, hands-on instruction was well-received by the students.

"Our teacher mostly uses chalk and chalkboard to teach and give questions to solve ourselves. But hands on learning with different materials was interesting and engaging"

2. Engagement and Enjoyment: Incorporating real objects, pattern blocks, and various images like PowerPoint presentations made math lessons more engaging and understandable. The incorporation of visual images

and real objects, according to the students, significantly improved their capacity for comprehension and problem-solving abilities.

"Getting opportunity to play with pattern blocks individually could keep us engaged and simultaneously got chance to see different illustration in the PowerPoint"

3. Comprehension of Concept: Visual tools like pattern blocks, real objects, and PowerPoint presentations enhance learners' understanding of abstract concepts, particularly fractions. These methods engaged learners through hands-on exploration, tangible demonstrations, and step-by-step illustrations, facilitating a deeper comprehension of fractional relationships.

"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. I also understood how fraction is related to our everyday life"

4. Enhanced Learning Satisfaction: Real-world examples and multimedia resources highlighted the importance of mathematics in everyday life. Visual aids simplify complex mathematical concepts, enhancing concept retention and making the learning experience more enjoyable and engaging.

"When the teacher taught us using real objects, I came to know that fractions are used in our daily lives"

5. Self-confidence: The intervention enabled students to develop a sense of self-confidence in their mathematical potential. This newfound confidence extended beyond fractions and influenced their overall perception of mathematics.

"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"

Discussion

The study highlighted the positive impact of using visual images in teaching fraction concepts to grade 4 Bhutanese students. Quantitative evidence supported the visual image approach, while qualitative interviews revealed students' satisfaction with the instructional strategy.

This comprehensive approach combined quantitative and qualitative methods, laying the groundwork for future mathematics instruction advancements. The study proved that integrating visual images could enhance students'

understanding and retention of mathematical concepts, leading to improved academic performance.

1. Students' Learning Achievement

The study found a significant Improvement in learning achievement, with a mean score of 12.81 in the posttest compared to 5.95 in the pretest. This outcome aligns with Shabiralyani et al. (2015) study, affirming that the incorporation of visual images in mathematics classrooms contributes to improved understanding, concept retention, and overall learning experiences. The study affirms the positive impact of utilizing visual images in mathematics instruction, underscoring the necessity of integrating such visuals into teaching methodologies. This conclusion is further reinforced by Rigzin and Chalermnirundorn (2021) investigation, which found that the use of multimedia technology (video and PowerPoint presentations) in mathematics education positively influences student satisfaction. The incorporation of multimedia, encompassing clear vocabulary, language, and relevant visuals, resulted in heightened satisfaction levels among students and facilitated a deeper comprehension and retention of mathematical concepts.

2. Students' Learning Satisfaction

The study's second major finding revealed that students exhibited positive learning satisfaction when visual images were incorporated into mathematics learning. The utilization of visual images in teaching and learning was perceived as thrilling, enjoyable, and uplifting, fostering inspiration and boosting participants' confidence in the subject. This positive reception aligns with the research conducted by Raiyn (2016), who emphasizes the significance of a novel visual learning strategy that capitalizes on learners' use of their eyes to gather visual information. The findings underscore the potential of such strategies not only to enhance satisfaction but also to contribute to the development of students' higher-order thinking abilities, particularly analytical thinking.

The use of visual images proved invaluable for learners who actively participated in discussions, group work, and hands-on activities to foster positive learning experiences. Furthermore, participants were more satisfied than those who sat in traditional, lecture-based settings. This finding was in line with the study conducted by Alake &

Salawu (2012), that PowerPoint is a versatile tool that can be used to teach mathematics to primary students in engaging and interactive way.

The semi-structured interviews revealed that visual images significantly enhanced mathematical education, aligning with engaging, interactive, and competency-based pedagogy principles, demonstrating their positive impact on teaching and learning.

Conclusion

The study highlighted the importance of incorporating visual images in mathematics instruction to improve pedagogical techniques and bridge the gap between theoretical abstraction and practical application. It emphasized the need for diversifying instructional approaches, with visual images being a crucial tool for enhancing comprehension and fostering enthusiasm for mathematics. By incorporating real objects, pattern blocks, and PowerPoint presentations into lesson plans, students experienced significant improvement in learning achievement and satisfaction. This approach not only enhanced the educational experience but also promoted a deeper understanding of complex concepts and catered to diverse learning preferences.

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