THE USE OF GAMES INCORPORATING MANIPULATIVES IN TEACHING GEOMETRY TO GRADE SIX BHUTANESE STUDENTS

BY

TENZIN JAMTSHO

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF EDUCATION
IN CURRICULUM AND INSTRUCTION
SURYADHEP TEACHERS COLLEGE

GRADUATE SCHOOL, RANGSIT UNIVERSITY
ACADEMIC YEAR 2019

Thesis entitled

THE USE OF GAMES INCORPORATING MANIPULATIVES IN TEACHING GEOMETRY TO GRADE SIX BHUTANESE STUDENTS

by

TENZIN JAMTSHO

was submitted in partial fulfilment of the requirements
for the degree of Master of Education in Curriculum and Instruction

Rangsit University
Academic Year 2019

Asst. Prof. Kittitouch Soontornwipast, Ed.D.
Committee Chairperson

Asst. Prof. Anchalee Chayanuvat, Ed.D.
Member

Nipaporn Chalermnirundorn, Ed.D.
Member and Advisor

Approved by Graduate School

(Asst. Prof.Plt.Off. Vannee Sooksatra, D.Eng.)
Dean of Graduate School
January 15, 2020

ACKNOWLEDGEMENTS

I am profoundly grateful to Thailand International Cooperation Agency and Royal Civil Service Commission of Bhutan for awarding me the scholarship without which my research would not have been possible. I extend my gratitude to the Ministry of Education, Bhutan and Rangsit University, Thailand for granting me the opportunity to pursue the Degree in Master of Education.

I would like to express my deepest gratitude to my thesis advisor Dr. Nipaporn Chalermnirundorn for being resourceful and gracious advisor who constantly provided constructive feedbacks and suggestions, moral support and guidance throughout the course of study period despite of her busy schedule. I am extremely grateful to the chairperson Assistant Professor Dr. Kittitouch Soontornwipast of Thammasat university and Assistant Professor Dr. Anchalee Chayanuvat, the committee member for their invaluable feedbacks, suggestions and unwavering supports which rendered the hitches during the course of the study.

I also extend my sincere thanks to all the experts who validated and rated the research instruments: Associate Professor Dr. Usaporn Swekwi, Mr. Dorji Wangchuk and Mr. Tashi. I also remain indebted to the principal, teachers, parents and research participants of the research school for being very supportive during the entire data collection period. I would like to extend my gratitude to Mr. Namkha Wangdi for his invaluable time spent to proof read my thesis paper besides his busy schedule. Finally, I genuinely thank my lovely parents, siblings, wife, children and friends for their sacrifices and supports which immensely contributed in completion of this study.

Tenzin Jamtsho

Researcher

6105772 : Tenzin Jamtsho

Thesis Title : The Use of Games Incorporating Manipulatives in Teaching Geometry to Grade Six Bhutanese Students

Program : Master of Education in Curriculum and Instruction

Thesis Advisor : Nipaporn Chalermnirundorn, Ed.D.

Abstract

A mixed method research was conducted to: 1) examine the effect of using games incorporating manipulatives on learning achievement in geometry of grade six Bhutanese learners and 2) find out perception of grade six Bhutanese learners towards the use of games incorporating manipulatives in learning geometry. The data were collected through pretest and posttest (quantitative methods) and analyzed using Wilcoxon signed rank test. The other instruments used were structured interview and structured observation (qualitative methods) and analyzed using thematic analysis. A section was selected out of two sections (consisted of 28 learners in each section) of grade six as research participants using Intact sampling method. The sample group was taught using games incorporating manipulatives for a period of one month.

The mean score 6.33 in pretest and the mean score 12.78 in posttest making the mean difference of 6.45 unfurled significant improvement in learning achievement with the significant value of .01. The data analyzed from structured interview and structured observation confirmed that the learners had positive perception towards the use of games incorporating manipulatives in learning geometry.

(Total 124 pages)

Keywords: Games, Manipulatives, Geometry

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

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLES OF CONTENTS (CONT.)

LIST OF TABLES

Page

Tables

LIST OF FIGURES

Page

Figures

ABBREVIATIONS

Abbreviations	Meaning
BCSEA	Bhutan Council for School Examination and Assessment
IOC	Item Objective Congruence
MoE	Ministry of Education
PISA D	Programme for International Student Assessment for Development
RCSC	Royal Civil Service Commission
REC	Royal Education Council
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
TICA	Thailand International Cooperation Agency

CHAPTER 1

INTRODUCTION

This chapter describes the background and rationale of the study; research objectives; research questions; scope of the study; limitations of the study; operational definitions; and the significance of the study.

1.1 BACKGROUND AND RATIONALE OF THE STUDY

The seed of modern education system was sowed since from 1914 when the First king of Bhutan Gongar Ugyen Wangchuck sent forty-six Bhutanese boys to India in pursue of western education (Tobgay, 2014, p. 2). In the same year the schools were established in Haa and Bumthang districts in 1915 (Dorji, 2005, p.10). According Takehiro (2015) those schools were educating crowned prince and children of royal attendants by then. The significant roles of western education was felt for country's development by the farsighted monarchs. Hence, during the reign of third King Jigme Dorji Wangchuck, modern education system was endorsed in First Five-year Plan in 1961 and started expanding throughout the country Takehiro (2015). Since then the age-old policy of isolation was pierced with the dawn of modern education.

Dukpa (2015) stated that "Mathematics had always been featured as a core and compulsory subject in the schools of Bhutan." Hence, the formal and comprehensive mathematics education was introduced in Bhutan along with the introduction of modern education system in early 1960s (Dolma, 2016). The system of mathematics practiced during those time were found teacher centered limiting students from active involvement in learning process. Therefore, since mid-1980s, there was a gradual transformation of mathematics curriculum which were aligned with constructivist theories and in year 2008, the curriculum was transformed which ensured student centered and implemented in the schools of Bhutan (Lham, 2017). However, the

learning achievement of Bhutanese learners in Mathematics is still found low as compared to the rest of the subjects.

A study conducted by the National Council of Bhutan revealed that "many learners had performed below expectations of their grade level on both basic and advanced academic skills, lacked basic communication and analytical skills…" The same concern was restated by the Minister of Education during the 17th Session of the National Council (June 22, 2016), on average a learner required one additional year to achieve the same level of competency for that grade (National Council of Bhutan [NCB], 2016). Based on the citation, the level of educational performance of most Bhutanese learners were below expectation which meant the performance level of mathematics curriculum is low as well.

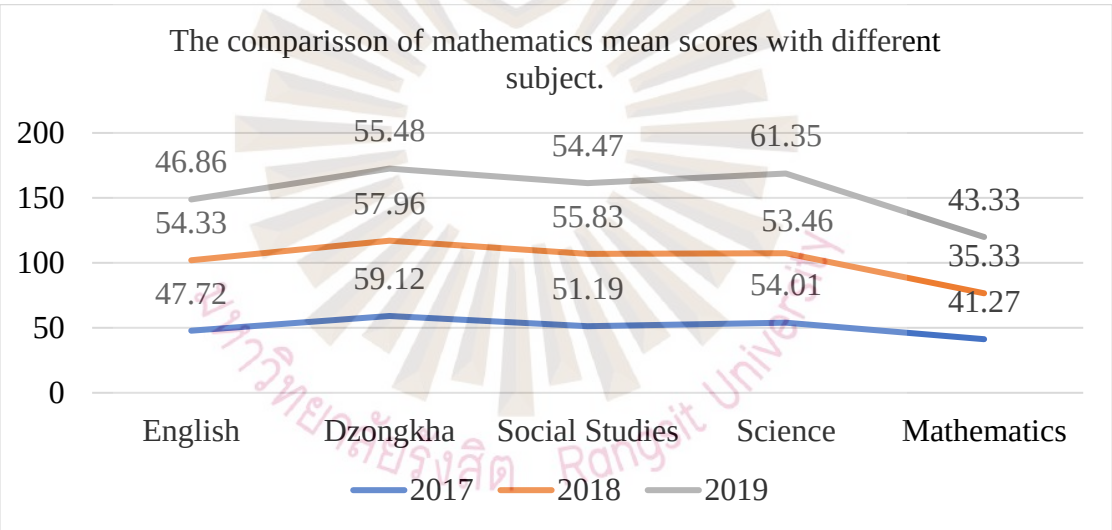


Figure 1.1 Comparing of grade six mathematics mean score with different subjects

Source: Bhutan Council for School Examinations and Assessment, 2017, 2018, 2019

As per Bhutan Council for School Examinations and Assessment (BCSEA, 2017) "The overall mean score was 59.12 in Dzongkha, 47.72 in English, 41.27 in Mathematics, 54.01 in Science and 51.19 in Social studies." Similarly, BCSEA (2018) reported the overall mean score of 57.96 in Dzongkha, 55.83 in Social Studies, 54.33 in English and 35.33 in Mathematics. BCSEA (2019) also reported that the overall mean score of 61.35 in Science, 55.48 in Dzongkha, 54.47 in Social Studies, 46.86 in English

and 43.33 in Mathematics. These reports showed that mathematics had remained the lowest scoring subject for three consecutive years by the grade six Bhutanese learners.

As per the performance assessment of three domains in PISA - D (Program for International Student Assessment for Development), candidates studying in both Classes IX and X performed better in Scientific Literacy with 41.78 and Reading Literacy with 37.41 mean score. The lowest was in Mathematical Literacy with 28.84 mean score.

Table 1.1 Details of the participants' performance in three domains

Domain	Students	Mean	SD	Minimum	Maximum
Scientific Literacy	3711	41.78	13.01	2.5	94
Reading Literacy	3909	37.41	13.53	6	86
Mathematical Literacy	3692	28.84	8.63	0	74

Source: BCSEA, 2018

The mathematics achievement scores of grades six in national standard displayed in Figure 1.1 and grade nine and ten in international standard showed in Table 1.1 concluded that Bhutanese learners had performed very poor in mathematics in both national and international level. Therefore, the fact disclosed was a great concern for all mathematics teachers in the country.

According to Dolma (2016), evidences in her study claimed that, the problem were not with the curriculum framework but with the way it was implemented in the classroom. Thus, it was concluded that, the age – old teacher centered teaching method still prevails in the classroom teaching. In the study of Jameel and Ali (2016) revealed that teachers being very strict in the process of teaching mathematics, limited activities and lack of learners attention were the main causes of low achievement in the mathematics as mentioned by students, teachers and parents respectively. The existence of rigid culture in the education system contributed in developing mathematics anxiety (Hamza & Helal, 2013).

One of the main factors that hampered the competency of the students in mathematics was the anxiety. Dobson (2012) claimed that, learners who suffered from anxiety reflected poor academic performance. Academic anxiety deluded children from academic success (Sara & Aida, 2014). The anxiety directly impacted learner's concentration and memory (Somia, 2010). A person who had math anxiety felt that they were bad in mathematics and they tend to hate the subject (Sokolowski & Ansari, 2017). Hence, anxiety can be seen as a greatest barrier which cultivated negative perceptions in the mind set of learners towards mathematics.

In the world of education, the educational hurdles were overcome by numerous inventions of strategies. One of the strategies gaining momentum in the twenty first century is the use of games. Game is an approach through which learners are driven through competition, engagement and immediate reward which fostered motivation and better achievements (Teen, n.d.). Games includes the use of computer and video games targeting to achieve better learning outcomes (Rivera, 2016). However, the schools in Bhutan can be seen not well equipped with the advanced technological facilities due to economic status and harsh geographical condition (Gyeltshen, 2018). Therefore, implementing gamification is not suitable in the context of Bhutanese schools but never the less, the implementation of games incorporating manipulatives is one effective alternative among many to overcome the hurdles in teaching mathematics.

The use of games incorporating manipulatives does not need the accessibility to internet and it is affordable as compared to digital gadgets. Moreover, manipulatives are being supplied in the schools by the government. Kontaş (2016) revealed that the long-term use of concrete manipulatives improved learner's perception toward mathematics along with the performance. Gundogdu (2013) also pointed out that, the use of manipulatives in the classroom have geared up performance of learners and developed positive perception towards mathematics subject. Sidiqi (2017) stated that, the mathematics anxiety can be reduced by usage of manipulatives in the process of teaching and learning.

The quote "I hear and I forget. I see and I remember. I do and I understand" by Confucious 551-479 BC, best described the function of manipulatives. Manipulatives provided learners with the hands-on learning situations letting them comprehend abstract mathematics concepts without difficulty assuring enjoyable learning (Furner & Worrell, 2017). Manipulatives contributed learners to learn with deeper understanding and minimum confusion (Hidayah, Dwijanto, & Istiandaru, 2018). The use of mathematics manipulatives delivered an opportunity to think critically, explore new ideas and find diverse solutions to the problem (Gerard, n.d.). Thus, the use of manipulatives in the classroom teaching is a perfect pavement through which learners were made to undergo educational interactions and active involvement with excitement to master the skills.

This study was carried out based on the principles for designing intervention in Mathematics (National Center of Intensive Interaction, n.d.). The principles for designing intervention highlighted the significance of games incorporating concrete mathematics manipulatives. In the studies conducted by Kontaş (2016); Gundogdu (2013); Sidiqi (2017); Furner and Worrell (2017); Hidayah, Dwijanto, & Istiandaru (2018) found that the use of manipulatives not only had a positive impact in the performance level but it changed the perception of students towards learning mathematics. Thus, the use of games incorporating manipulatives would have a positive impact on teaching mathematics in Bhutanese classroom. Children's development in primary level is very important part in the educational journey as they are developing their feelings of ability and confidence to develop skills. Therefore, educators must help learners in developing skills through encouragement (Aarnos & Perkkila, 2012).

1.2 RESEARCH OBJECTIVES

1.2.1 To examine the effect of using games incorporating manipulatives on learning achievement in geometry of grade six Bhutanese students.

1.2.2 To find out perception of grade six Bhutanese students towards the use of games incorporating manipulatives in learning geometry.

1.3 RESEARCH QUESTIONS

1.3.1 Did the use of games incorporating manipulatives have an effect on the learning achievement of grade six Bhutanese student in geometry?

1.3.2 What was the perception of grade six Bhutanese students towards the use of games incorporating manipulatives in learning geometry?

1.4 RESEARCH HYPOTHESES

1.4.1 The use of games incorporating manipulatives had positive effect on the learning achievement of grade six Bhutanese student in geometry.

1.4.2 Grade six Bhutanese students had positive perception towards the use of games incorporating manipulatives in teaching and learning geometry.

1.5 SCOPE OF THE STUDY

1.5.1 Population and Sample

The population of the study was composed of 56 learners from two sections of grade six learners in one of the schools in Bhutan. The age of the learners ranged from 12 – 14 years old with a mixed gender classroom. The researcher used intact random

sampling technique to select one section (28 students) out of the two sections of grade six consisting mixed ability students as a sample group.

1.5.2 Content of the Study

In this study, the researcher taught grade 6 mathematics text on Unit 6: Geometry developed by Department of Curriculum and Research Development (DCRD). This unit consisted three chapters and each chapter was further divided into topics as shown in Table 1.2. The researcher taught all four topics from chapter 1 titled '3 -D Geometry.' Pretest was conducted before and posttest after the using games incorporating manipulatives in teaching geometry.

To align researcher's plan with the teaching plan of the mathematics teacher of the research school, the researcher discussed about the chapter that he was supposed to teach in the month of August as per his yearly plan. The topic suggested was '3- D geometry' and the detailed information about the topics are displayed in Table 1.2.

Table 1.2 Table of content for the lesson

Lesson Plan	Topic	Time
I	Explore: Planes of Symmetry	First week of August
II	Explore: Cross – Section	Second week of August
III	Interpreting Orthographic Drawing	Third week of August
IV	Creating Orthographic Drawing	Fourth week of August

1.5.3 Time Frame

The data was collected in the month of August, 2019. The detailed time frame of the entire study was presented in Table 1.3.

Table 1.3 Time Frame for the Research Process

Activities	Time Frame			
	From		To	
	Month	Year	Month	Year
Literature Review	January	2019	December	2019
Proposal Defense			June	2019
Data Collection	August	2019	September	2019
Data Analysis	September	2019	December	2019
Article Writing	September	2019	November	2019
Final Defense			December	2019

1.5.4 Location of the study

The study was carried out with grade 6 students from one of the primary schools in Trashiyangtse District, Eastern Bhutan and it is in the semi-urban setting.

1.6 LIMITATIONS OF THE STUDY

1.6.1 The study was limited itself to a section of grade six students in one of primary school in Trashiyangtse District, Bhutan. Therefore, the findings do not depict the performance of all grade six students in Bhutan.

1.6.2 The study was confined to the use of games incorporating manipulative in teaching geometry. Therefore, it does not generalize of its application on other topics in mathematics curriculum.

1.7 CONCEPTUAL FRAMEWORK OF THE STUDY

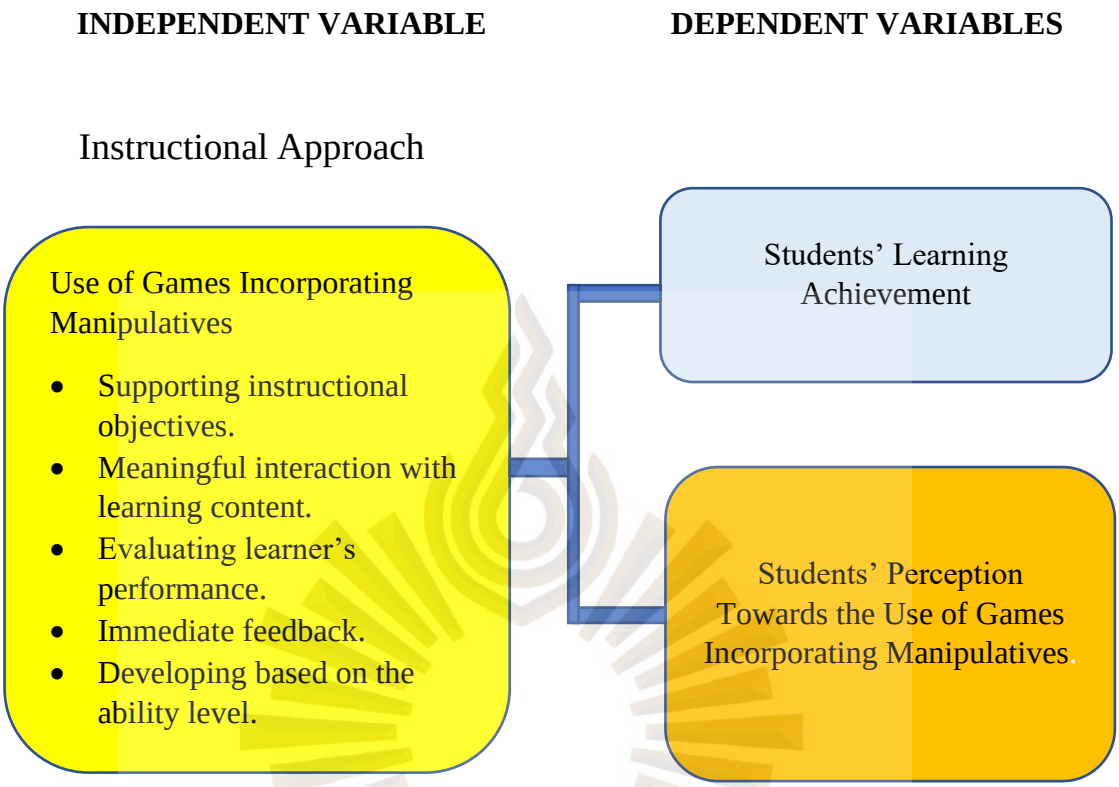


Figure 1.2 Illustration of the independent variable and dependent variables.

1.8 OPERATIONAL DEFINITION

Effects referred to the changes that occurred in the learning achievement of learners after the use of games incorporating manipulatives.

Games incorporating manipulatives referred to games like Building castle, Hangman, Human Tic Tac Toe and Mathematics Base Ball which will be played using manipulatives like snap cubes, set of 3-D shapes and isometric dot paper which was used as learning materials during treatment session.

Geometry referred to the topics like Planes of symmetry, Cross section, Orthographic drawing and interpreting orthographic drawing that had been taught to the sample group during the treatment session.

Grade six students referred to the students studying in 6th standard aged between 13 to 15.

Perception referred to the students' positive thinking towards of use of games incorporating manipulatives in treatment session.

1.9 SIGNIFICANCE OF THE STUDY

1.9.1 The study would have positive impact in learning achievement of grade six students with the use of games incorporating manipulatives.

1.9.2 The study would be useful for the Mathematics teachers in Bhutan to improve their teaching strategy.

CHAPTER 2

LITERATURE REVIEW

This chapter presents the Mathematics Curriculum of Bhutan, using games incorporating manipulatives as an important strategy, the theoretical background of games incorporating manipulatives and review of related research for the strategy in use across different countries.

2.1 MATHEMATICS CURRICULUM IN BHUTAN

In Bhutanese education system, children get enrolled in early childhood care and development at the age of three and then at the age of six they get enrolled in the formal school starting from pre- primary level. The path way of Bhutanese education system lets children to attend seven years of primary education, four years of secondary education, two years of higher education and then tertiary education. First eleven years of education is considered as the basic education which is comprised of seven years of primary education and four years of secondary education. To get enrolled in the higher education, every learner has to appear common examination and the candidates are selected on merit basis (Bhujel, 2012). In these entire educational stages, mathematics has been prioritized and introduced since from the pre-primary level until tertiary.

According to Dorji (2005) when western education was first introduced to Bhutan, the contents taught in the schools were mostly about places, people and events of other countries. The content taught in the schools were found irrelevant in Bhutanese context. Therefore, in 1976 the Department of Education drafted the first education policy in the country. The school curriculum was prioritized towards instilling skills to the learners to meet the evolving needs for skilled workers for the developmental plans and programs. In 1984, the 1976 policy was redrafted and redeveloped a curriculum which helped Bhutanese learners to learn about own traditional beliefs but also about

the people and culture of other countries especially about the technology. The curriculum was framed which blended Bhutanese tradition with the emerging modern technology. However, the curriculum framed in 1984 was not formally published all over the country hence in 1993, Curriculum and Textbook Development Division (CTDD) was formed which later changed to Curriculum and Professional Service Division (CAPSD) developed syllabuses and textbooks for the schools. Since from 1994, various officials conducted study regarding the teacher professional development, assessment, pedagogical practices in all the subjects. The study for Mathematics was conducted in 2003 and 2004 and found the need to reframe the Mathematics syllabus from preprimary to secondary level.

Curriculum and Professional Support Division (CAPSD, 2005) the mathematics curriculum in Bhutan is designed with sequential and developmental logical framework from classes PP till 12. The design of mathematics curriculum aimed to shift the classroom teaching practice from teacher - centered towards learner - centered as a vehicle to change students' attitude from negative to positive towards learning mathematics. The curriculum intended to let learners appreciate and love the nature of the subject and its relevancy in their day to day life. The mathematical concepts are presented in seven strands from Pre- Primary till grade Twelve: Numeration, Operations, Patterns & Relations, Measurement, Geometry, Data and Probability as per the NCTM. The new curriculum is developed based on the principles and standards set by National Council of Teachers Mathematics in USA (ibid).

According to CAPSD (2009) following mentioned bulletins are the key objectives that the new mathematics curriculum intends to fulfill:

1) Develop related concepts, skills and contribute to work confidently in the areas of numbers, algebra, measurement, geometry and data handling.

2) Develop the ability to think critically, strategically and logically in varying contexts.

3) Develop the skills to structure and organize, work out procedures and represent and communicate information effectively.

4) Create models and predict outcomes to reason and justify, seek patterns and generalizations.

5) Make reasonable estimate and calculate with precision and use step by step investigation to make interpretations.

Ministry of Education (2019), the Bhutanese education system aimed to provide quality education to every single Bhutanese child regardless of intellectual ability, academic performance, gender, special needs and socio-economic background. Therefore, every Bhutanese child are provided with the basic education, tertiary education, non – formal and continuing education, special education and early childhood development programs.

2.2 DEFINITION OF MATHEMATICS

Hom (2013) defines that, the mathematics is the science that deals with the study of structure, order and relation of counting, measuring with logical reasoning which every individual use it in the form of devices, building blocks, money, art and sports. Mathematics is a subject which is dealt by everyone in everyday life helping to interpret definite ideas with logical reasoning and also helps in revealing hidden patterns for new discoveries (Khan, 2015) Mathematics has been called the language of the universe (Zyga, 2013). Mathematics is the study that deals with the pattern and logical reasoning contributing to new discoveries.

The importance of mathematics is parallel to the advancement of technology as mathematics is what actually computer does. The mathematics work as a black box for its user, as it is invisibly present in everyone's everyday life. The mother nature is the greatest mathematician as the concepts, laws, patterns, shape, etc… are found in the nature and mathematics is the backbone of the all science (Sushmita, 2012). Legner

(2013) claims that, every individual use mathematics in everyday life starting from the time we allocate for different work purpose, ratio of sugar and milk that we add in a tea, the suitable colored clothes that we choose to wear, etc.… so, mathematics is applied throughout our life. These skills are taught since from the primary level of school.

According to the research studies, the learner's low performance in mathematics is not a concern just for few countries rather it is the concern of every nation in the world. Taylor (2018) states that, there are just handful of eighth grader learners who scored above the proficient level and mostly scored below proficient level according to the data from National Assessment of Education Progress of Kentucky, United State. Maliki, Ngban, and Ibu (2017) expresses similar problem stating that, the low performance in mathematics by the learners has become a serious concern in Nigeria.

Many researchers claim that one of the reasons for the low achievement in mathematics is due to mathematics anxiety. Mathematics anxiety impacts the learner's performance. Leppavirta (2013) states that learners with higher mathematics anxiety performed low and learners with lower mathematics anxiety performed high. The learners with mathematics anxiety not just performed low in mathematics but they disliked and avoided mathematics (Maloney, Schaeffer, & Beilock, 2013). According to Attentional Control Theory cited in Luttenberger, Wimmer, and Paechter (2018), the effective function of cognitive hinges on two attention system that are goal driven system (attention to current goal and expectation) and stimulus- driven system (attention to tangible stimuli of the environment). Anxiety imbalances the two attention systems and lets stimulus – driven system to overtake. Where learner's attention is driven more on possible threats than the lesson explained in the class.

Yilmazera and Keklikci (2014) states that, teaching geometry using traditional teaching methodology did not improve learner's performance. Olubokola (2015) points out that, one of the topics that most students face difficulty in understanding the concepts is geometry and trigonometry due to the abstract nature of the topic. Fabiyi (2017) also explains that, learners face difficulty in geometry concepts (congruent triangles, circle theorem, construction, surface areas of solid figures, etc... So, games incorporating

manipulatives must be an appropriate method to make learners learn the concept of these topics swiftly.

2.3 GEOMETRY

The word Geometry is derived from a Greek word ‘Geo’ and ‘Metron’ where ‘Geo’ refers to earth and ‘Metron’ refers to the measurement. So, Geometry means measurement of the earth. Choudhary, Dogne, and Maheshwari (2014) defines the term Geometry as a science which describes structure (structure is derived from a Latin word ‘Structura’ meaning arranging things in order). According to dictionary (Webster, 2003) Geometry is “A branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids.”

According to Euclid, Heiberg, and Fitzpatrick (2008), The geometry comprises thirteen books of elements; Book 1 expresses the important system of plane geometry, book 2 talks about geometric algebra, book 3 deals with circle and their properties, book 4 deals with regular polygon in relation to circle, book 5 deals with arithmetic theory of proportion, book 6 deals with the application of proportional theory, book 7 deals with basic arithmetic theory, book 8 deals with geometric series, book 9 deals with application (of answers from basic number theory and geometric series) with prime numbers, book 10 deals with categorizing irrational scale using the “method of exhaustion,” book 11 deals with basic arrangements of 3 dimensional geometry, book 12 deals with the calculation of volumes of 3 – D shapes and book 13 deals with Platonic solids.

Among the geometry elements stated above, the topic that the researcher is going to teach during the data collection will be basic arrangements of three-dimensional geometry (3 – D). According to (Guha, 2015) three-dimensional (3- D) object is solid rather than flat, because it can be measured in three different directions, usually the height, length, and width. Three- dimensional objects poses areas like Apex, edge, face, base and corner. Three-dimensional (3-D) objects are characterized by width, length and depth, such objects are also called solids (Crowell, 2016).

The concept of 3D models is seen very useful for a diverse purpose in the field of video games, movies, architecture, illustration, engineering, and commercial advertising (Petty, n.d.). The introduction of 3D model has benefited the specialists like engineers and architectures to finish projects quickly, efficiently and within budget (Diaz, 2014). To explain and understand the cellular characteristics of any tangible objects is difficult without a mathematical model due to its abstract nature (Umulis & Othmer, 2012). During the early schooling, topics on shapes and solid are focused more in geometry, gradually focusses on higher level of learning skills like properties and relationships which advances to accumulate skills like problem solving, transformation, symmetry and reasonings (Russell, 2018).

2.4 GAMES

Harris (2009) claims that, Instructional games are those types of games that can be integrated to simplify learning such as: board games, computer games, locally constructed or commercial games, physical games, puzzle games, online games, card games, etc. Instructional game is an approach which are inclusive of competition, interaction and fun while acquiring knowledge (Editorial Team, 2013). Plass, Homer, Kinzer and Ken (2015) states that, the game is not only supposed to be digital games, it can be any other games which adequately cover the subject matter along with the game play. Instructional games are the games which aims to enhance learning by discouraging inflexibilities in the process of teaching and learning guided by the set of rules (Udosen & Ekpo, 2016).

The studies evidently show that, Instructional games contributed immensely in achieving better performance in mathematics. In the comparative study carried out by Bahrami, Chegini, and kianzadeh (2012) states that, the group of learners in Instructional game achieved significantly high score than the group of learners in traditional teaching method. Ku, Chen, Wu, Lao, and Chan (2014) also claims that, the infusion of Instructional game not only had positive impact in harvesting colorful results but also improved the confidence of the students in mathematics. Instructional game is a practicable teaching method which provides opportunities to the learners to improve

academic achievements in Science, Technology, Engineering and Mathematics subjects (Musselman, 2014).

2.4.1 Developing Instructional Games

Every game cannot be considered as instructional game since there are games designed just for the purpose of fun without any leaning purposes. The instructional games should be designed to achieve specific learning objectives. Therefore, Udosen and Ekpo (2016) laid couple of characteristics of instructional game as follows:

1) The game designed must support the stated instructional objectives.

2) The game must provide opportunity for learners to have meaningful interaction with the learning content.

3) The game must provide means for evaluating the learner's performance to see if the intended instructional objectives of the lesson have been achieved.

4) The game must provide a means for immediate feedback. The feedback should be given to the learners as soon as possible for corrective measures or remediation.

5) The game should be developed based on the ability level of the learners. If the task to be accomplished is too difficult, the students may give up easily and may become bored if it is too easy.

2.4.2 Instructional Design Model

As a teacher, any instructional game design should be guided by the principles of instructional design to meet the lesson objectives and fulfill learners' expectations. Lee and Jang (2014) elucidates that, instructional design is a method, framework and a tool which guides instructors to prepare any instructional resources to align with learning objectives and fulfill the desired expectations. An instructional design is the systematic planning, evaluating and revising guided by the design- based discipline

(Cennamo & Kalk, 2019). The following model is one of the commonly accepted prescriptive models used for designing or selecting instructional strategies:

Addie Model

The Acronym ADDIE stand for five phases of the model. A – Analyze, D- Design, D- Development, I- Implementation and E- Evaluation.

Aldoobie (2015) describes that, in the analysis phase, instructional problem is simplified, the instructional goals and objectives are set up and the learning environment and learner's prior knowledge and skills are recognized. The design phase deals with learning objectives, assessment tools, activities, content, subject matter scrutiny, lesson planning and media selection. The development phase is where the designer develops and gather the information that were created in the design phase. During the implementation phase, the instructional design should cover the intended content area and fulfill learning outcomes through systematic method of delivery, and testing procedures. The evaluation phase consists of two parts: formative and summative.

Assure Model

The acronym ASSURE stands for A — Analyze learners, S — State standards and objectives, S — Select strategies, technology, media and materials, U — Utilize technology, media and materials, R — Require learner participation E — Evaluate and revise.

Kurt (2015) clarifies that, In the analyze step, teacher must analyze the capabilities of learners and emphasize on the learning outcomes. In the next step, teacher, must state specific objectives of what learners should acquire after the course. In the next step, teacher must select appropriate strategies, materials and technologies. In the next step, teacher should utilize the teaching materials contributing to fulfill the desire learning outcomes. In the next step, teacher must be able to let learners participate

actively. In the final step, teacher should evaluate the teaching strategy, materials used and overall lesson procedure.

2.4.3 Types of Instructional Games

Simulation Games

Simulation games transforms complex nature of reality in an easier form, which helps the learners to comprehend abstract ideas in more organized way. Lean, Moizer, Towler, and Abbey (2011) states that, simulation intent to emulate real life situations within a created situation. Simulation is a method of rehearsing the skills that can be useful to diverse subject areas. It is a method that imitate significant aspects of the real world in a fully interactive manner (Lateef, 2010). Deshpande and Huang (2008) defines simulation as "representation of reality or some known process/phenomenon."

Situational Games

The main idea of this game is to test the learners, whether they can solve the tasks assigned providing imaginary situations. Voigt and Dijk (2012) describes in their study "situational games are played for a cause, on the spot, and in interaction with the actual situation at that spot." Situational game-based learning is an active process of involvement with the given situation related to subject matters and come up with the appropriate solutions through rigorous discussions and decision-making process (Kirk & MacPhail, 2002).

Staging Games

Staging games needs the imitation of past events or create new event related to the subject matter. Staging game is a type of play where learners agree to take the roles and act them out. It is an active teaching method which integrate positive fundamentals of learning such as inculcating skills and knowledge with enjoyment (Erturk, 2015).

All those three types of games are applicable in teaching mathematics. However, the researcher has chosen simulation game as it is most appropriate with the content that the researchers is going to teach during the data collection that is geometry. The finding in the study carried out by Ajai (2013) points that, the use of games and simulations in teaching mathematics concepts had a great significant where the administrators decided to integrate local games to facilitate meaningful learning of mathematics. Vlachopoulos and Makri (2017) also conducted similar study and displays that the use of games and simulations have a positive impact on achieving learning goals.

In the research study carried out by many researchers like Lean, et al. (2011); Lateef (2010); Deshpande and Huang (2008) generally defines simulation as a representation of reality. Larbi and Mavis (2016) defines, manipulatives are any representational object that can be used for teaching and learning mathematics concepts. The definitions of simulation and manipulatives cited from the research studies as mentioned above, both terms are used as representing real objects through the use of models in the process of teaching and learning. Thus, researcher choose to use manipulatives in this study.

2.5 MANIPULATIVES

The term “manipulates” evolved from the old French word “manipüle”, which means to “handle”. manipulative is a teaching material which helps students to understand mathematical concepts by operating it (Istiandaru, Istihapsari, Prahmana, Setyawan, & Hendroanto, 2017). According to Bartolini and Martignone (2014), Mathematical manipulatives are the objects used by learners in mathematics education to explore, and investigate mathematical concepts to solve the problem during activities. Mathematical manipulatives are tangible objects that is used during the mathematics lesson by the learners and educators to teach and learn abstract concepts (Back, 2013). Manipulatives are any object that can be used for teaching and learning mathematics concepts (Larbi & Mavis, 2016). Manipulative materials are real objects that include mathematics concepts triggering several senses through touch and move around by the learners (Al-Absi, Nofal, & Jordan, 2010).

The importance of mathematics manipulatives was felt since many centuries back. The researchers and theoreticians believed that learners must understand what they are learning and the skills and knowledge learnt must sustain life long. According to Moyer (2002) the theory of Zoltan Dienes's convinced scholars and researchers that the use of varied physical representation contributed in instilling mathematics concepts to the learners in more organized way.

According to National Council for Teachers of Mathematics (NCTM, 2010, as cited in Furner and Worrell, 2017) a representational model can be classified into illustrations, virtual manipulations and concrete manipulatives.

Virtual Manipulatives

Packenham, Bolyard, and Spikell (2002) defines that, virtual manipulatives are "an interactive, Web-based visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge" (p. 372). According to Dorward (2002, as cited in Furner & Worrell, 2017) virtual manipulatives are a computer-based form of common mathematics manipulatives and tools.

Concrete Manipulatives

According to "Manipulative" (2009, as cited in Cope, 2015) a concrete manipulative is an object, "designed to be moved or arranged by hand as a means of developing motor skills or understanding abstractions, especially in mathematics." Concrete manipulatives are the tangible objects that can be physically touched by the learners and gain concepts through sensory experiences (Bartolini & Martignone, 2014).

2.5.1 Guidelines for Using Manipulatives in the Classroom

Manipulatives must be used strategically to have effectiveness like any other teaching and learning materials. Burns (n.d.) states following guidelines to use manipulatives effectively in the classroom:

1) Talk with students about why and how manipulatives help them learn math. These discussions are important for first-time users. Teacher must provide ample time to the learners to explore manipulatives. Then let them talk about what they observed. Then teacher will present the concepts that learners must learn with the use of materials.

2) From the first day itself, teacher must set ground rules for using materials., they are given definite problems and activities with manipulatives but they must be allowed to make discoveries and explore new ideas with the help of manipulatives.

3) It's also important for students not to disturb one another. Teacher must interfere if learners complain about insufficient manipulatives and manage from other groups.

4) Set up very clear management system of storing manipulatives. The manipulatives must be accessible to the learners any time and they must be responsible to take care.

5) Time for free exploration must be provided to the learners to get familiarize with the manipulatives. Whenever teacher present a manipulatives teacher must allot at least one math period for the student to get familiar. Free exploration time allows learners to satisfy their curiosity so that they don't get distracted from the tasks.

6) Manipulatives are a natural for writing assignments. They provide concrete objects for learners to describe and understand abstract ideas.

2.5.2 Impact of Using Manipulatives in Mathematics

Larbi and Mavis (2016) states that, mathematics manipulatives are important tools for learners in the learning of mathematics and teachers to impart mathematical concepts and to assess their understanding. Liggett (2017) evidently supports in his

study that, manipulatives are effective in inculcating mathematics concepts and skills especially to the learners with mathematical difficulties. learners learn in different ways therefore, when manipulatives are executed it triggers and gather senses into learning as learners can touch and move objects to make visual representations of mathematical concepts Al-Absi et al., 2010). The manipulatives are seen important as it contributed in achieving higher scores of the experiment group significantly than the control group (Kontas, 2016).

2.6 GAMES INCORPORATING MANIPULATIVES INTO THE CURRICULUM

2.6.1 Planes of Symmetry Integrated with Building a Castle

Teacher divided learners into groups of four and provided clay and a set of 3-D blocks in each group. Learners used 3-D blocks to construct castle (for game) and made structure out of clay as listed on a board (cube, cone, cylinder, prism, and pyramid). Learners had cut the shapes in different ways to find planes of symmetry. They Listed all possible planes of symmetry for each structure. As soon as they completed listing all possible planes of symmetry for each structure, a member in a group used 3-D blocks to construct the castle layer by layer as a sign of victory. A group which had the most complete castle was declared as the winning group.

2.6.2 Cross Sections Integrated with Hangman

Learners were divided into seven groups composed of 4 members in a group. The learners were numbered 1 till 4**.** Seven questions were provided to the groups where the members had to answer by exploring (Cut the shapes from different angles) the cross- sections in a particular structure with the help of models or manipulatives provided. Each group presented their work to the class and assessed their works using Hangman game. For every mistake against the question the drawing proceeded through 7 steps as following:

Step 1: Draw rope

Step 2: Draw head.

Step 3: Draw body

Step 4: Draw eight hand

Step 5: Draw left hand

Step 6: Draw right leg

Step 7: Draw left leg

A group which had least part of the drawing was declared as the winner. The mistakes were corrected, the overall feedbacks and suggestions were also provided by the teacher immediately after the presentation.

2.6.3 Interpreting Orthographic Drawings with Tic – Tac – Toe

Learners were grouped into 8 comprised of 4 members in each group. Each learner was numbered 1 till 4. Nine questions with four multiple choices were provided to the group. The questions were presented from simple to difficult level. Groups labelled A, B, C, D, E, F, G, H and paired the groups for competition through drawing game fixture.

For each game there were 6 main questions and 3 substitution questions. The time allocated for each question was 3 minutes. The group which found the solved the problem before time said 'BINGO' and showed their answers to the teacher along with the model made from linking cubes. A group marked their group name in the Tic-Tac-Toe diagonally, vertically or horizontally when the answer was correct. The process continued until the final round where one group had been declared as a winner. The immediate feedbacks and suggestions were provided by a teacher after the game.

2.6.4 Creating Orthographic Drawings with Mathematics Base Ball

The learners were divided into groups of four members. Teacher provided linking cubes and a set of question consisted of structures and a sample net of Cube.

Nine questions were provided in each group where every group answered questions by exploring and evaluating all five aspects of two dimensions in 3-D structures with the help of Linking cubes. Every groups were provided equal chance to answer the questions. Each group presented their work to the class and evaluated their answers with Mathematics Baseball game. For each answer the total score will be 3. The questions which could not be answered were passed to next group and 0.5 points was deducted in every pass of the question. A group scoring the highest point was the winner. The overall feedbacks and suggestions were provided by the teacher immediately after their presentations

2.7 RELATED RESEARCH STUDIES

In the study carried out by Makri and Vlachopoulos (2017) states that simulation games are the powerful educational method which established conducive learning environment through which learners obtain knowledge and skills across the subjects. Simulation games are believed as a teaching method where learners enjoyed and encouraged to participate actively and collaboratively. In such learning environment learners are provided with the opportunities to develop critical thinking, take accountability for decision making, problem solving. Thus, simulation games contribute in experiential learning.

In the study conducted by Akinsola and Animasahun (2007) discloses that integrating simulation game in teaching mathematics was very important strategy which contributed in advancing the learners learning achievement and positive attitude towards mathematics. The simulation games helped in reducing the learner's difficulties in learning mathematics as learners were offered with the opportunities to learn practically which made teaching and learning mathematics practical, expressive and retainable.

Kontas (2016) explains that there is an impact of mathematics manipulatives in improving learner's mathematics achievement as well as attitude towards mathematics. The study declared that, mathematics manipulative played a crucial role in imparting mathematics concepts and skills to the learners as the result of the study. Gundogdu

(2013) clearly discloses that, there was significant improvement in performance achievement in the posttest as compared to pretest. It is also confirmed that, the Mathematics manipulatives has greatly impacted in learner's perspective towards Mathematics subject.

Liggett (2017) conducted a study to find the possibility of implementing manipulatives to improve learners test score and attitude towards mathematics. So, the researcher gathered data through the comparison of test scores from pretest and posttest. The result of the study favored and proved that; the use of mathematics manipulatives was very effective in elevating the test score as well as to groom positive attitude towards mathematics subject since posttest score was significantly better than the pretest score.

Larbi and Mavis (2016) states that, manipulatives provided a meaningful learning experiences helping learners to construct their own mathematical ideas and promote the skill of inquiry- based learning. Hence, the use of manipulatives in the process of teaching and learning yielded longer retention which enhances learner's motivation to learn mathematics ultimately leading to achieve better test results towards the end.

Furner and Worrell (2017) states that, mathematics manipulatives are valuable only when teachers make the relation between the representation and the abstract concept otherwise, just manipulatives used by the learners themselves does not impact the learning. Therefore, it has been observed that, when teachers use manipulatives to impart the abstract mathematics concepts, it has a great impact on the learners in understanding the key concepts. Teachers' ability to use manipulatives to impart concept is very pivotal.

2.8 RELATED LEARNING THEORIES

2.8.1 Piaget's Theory of Cognitive Development

Jean Piaget's cognitive development specifically elaborated on how children develop and perceive the model of the world. His theory claimed that the intelligence of a person cannot be limited at certain point as it can develop according to the maturity and the way person perceives environment. Piaget's theory on cognitive development has assembled lots of attention in the field of education. According to his theory, children's development takes place stage by stage as children attain certain age level. These stages are identified in four different levels: sensorimotor stage (birth to 2 years), where toddlers acquire information through sensory experiences and motor responses especially the eye hand coordination; preoperational stage (2 to 7 year s), where children develop the symbolic thought and learn to use language; concrete operational stage (7 to 11 years), where children develop logical and organized thinking; Formal operational stage (11 years and above), where children develop the ability to think abstractly and reason hypothetically.

The four stages of child's cognitive developments framework helped the educators to understand and realize that educators cannot use similar teaching strategies for all levels of learners. Jean Piaget's cognitive development theory helps the educators to find out the cognitive levels of the learners through observation. Thus, educator can plan and design an appropriate lesson to enhance children's learning. According to Piaget, young learners are not matured enough to comprehend abstract mathematical concepts through sign and symbols. Therefore, in this research study, a researcher will examine the effects of using games incorporating manipulatives for inculcating abstract concept of geometry grounded by cognitive development theory.

2.8.2 Lev Vygotsky's Zone of Proximal Development

Karim, Mohamad, and Saman (2010) describes that, the idea of zone of proximal development was first established by Soviet psychologist and social constructivist Lev

Vygotsky (1896 – 1934). He has defined zone of proximal development as the gap between what learners know and the learner is going to learn through guidance and encouragement from a more knowledgeable person to master what learners does not know.

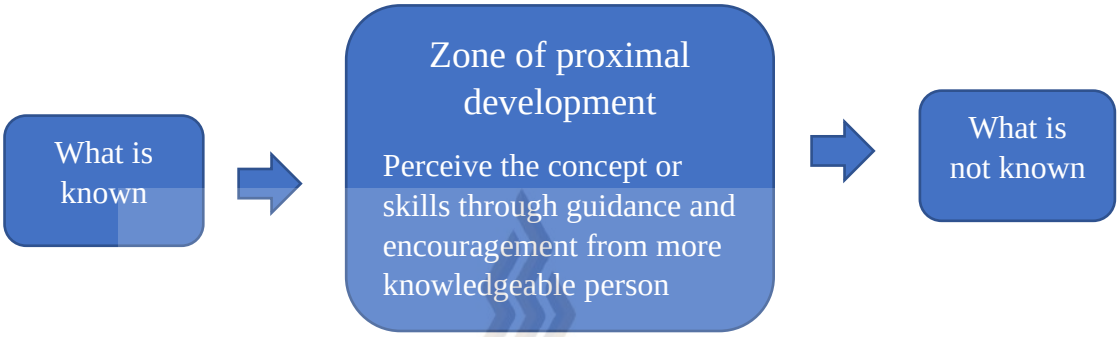


Figure 2.1 Model of zone of proximal
Source: Karim et al., 2010

Vygotsky, explained that when a student is in the zone of proximal development for a particular assignment, giving appropriate assistance helps learners to understand the concepts that the teacher is intended to instill. While assisting, all three levels of zone of proximal development must be considered seriously as an educator:

Presence of more knowledgeable others (MKO). The MKO can be a teacher or any other adult but must be more knowledgeable and experienced than the novice in a particular concept that the learner is dealing with.

Social Interaction: The child learns best through social interaction with MKOs in the society. The ideas that a child gained from MKOs will be later analyzed and execute it in their assignments which foster to reveal child's creativity.

Scaffolding: The concept of zone of proximal development and scaffolding share common principles and ideas though Vygotsky never used the term scaffolding. The theory of Scaffolding was developed and introduced by Wood, Bruner and Ross (1976). The idea of scaffolding is to provide necessary support to the novice to master

the particular concept. The adult support or assistance is removed gradually when it becomes unnecessary and child achieve in perceiving higher level of skills and concepts.

According to Mcleod (2019), it is found that the combination of the theory of zone of proximal development and theory of scaffolding work very effective as it enhances learner's achievement in a new height which they have not been able to achieve separately before.

Vygotsky's theory of zone of proximal development will help the researcher to understand the key role of a researcher in the classroom during the teaching learning process. It will help researcher not only when to interfere but it will guide on how to support students in perceiving ideas and skills. According to the theory, a researcher needs to check the prior knowledge of the students by observing, questioning and letting them share ideas about the lesson. The main intent of the theory is to find out what learners know already and what they are going to master after teaching the lesson. The key role of the researcher begins here on planning how lesson should be imparted and provide necessary supports to the learners. This theory will help educators to have a clear vision about the objectives of the activities and specific learning outcomes mentally, which will guide educator's intervention in a most appropriate way and time.

2.8.3 Constructivism

Constructivism is a theory which emphasizes that individual learner will try to make sense of all information that they perceive and construct their own meaning from that information (Bada, 2015, pp. 66-70). It focuses on the student-centered learning where the learners work with their society and construct the knowledge socially. Learners are thought to use prior knowledge and concepts to help them in their acquisition of information. According to constructivist approach, instructors have to act as facilitators and not teachers. Every learner is an active doer not the passive listener. Therefore, teachers have to design the learning environment which best support to overcome the challenge that a learner have.

Piaget's theories focus on the active role of the individual in learning which relates much on constructivist principles. According to Piaget's theories, it is the role of a teacher to establish a mathematical environment to enable learners to construct mathematical knowledge. In such learning environment learners would be provided with the opportunities to assume, test out their thinking, manipulate materials, and communicate their understanding in order to build mathematical knowledge. Teachers are glanced as facilitator facilitating learners while solving a given problem, scrutinizing learner learning and conveying meaning and understanding to the student. Students are given a great deal of autonomy in a constructivist classroom.

The use of manipulatives in the teaching and learning of Mathematics is an approach developed by the emergence of constructivist which firmly explains that children construct their own knowledge through their interaction with their environment and each other. Children begin to understand symbols and theoretical concepts only after experiencing the ideas on a concrete level (Piaget & Cook, 1952). Students who learn with the help of manipulatives will learn the abstract mathematical concepts faster than those who learn without using manipulatives. Manipulative embedded classroom provides an opportunity for the students to participate actively and be responsible for their own learning.

The above-mentioned related studies on games incorporating manipulatives in geometry have concluded that the games incorporating manipulatives has the positive impact in the process of teaching and learning mathematics. It is evident that games incorporating manipulatives is one of the appropriate teaching learning strategy for the twenty first century learners and educators since it is characterized by child centered approach. That is why, the concentration of global education system is drawn towards the games incorporating manipulatives in the curriculums since it has the potential to achieve not only the intended lesson objectives but develop learners cognitive, social, physical and emotional well – beings through active interaction, participation and focused. This makes learning fun and motivates learners to learn deeper meaning. Games incorporating manipulatives creates conducive learning environment where

every learner feels safe, respected, loved and cared which caters them with the platform to perform their ideas and thoughts without fear and hesitation.

The researcher felt the use of games incorporating manipulatives will be the correct treatment during the time, when students across the country is evidently diagnosed performing below expectation in mathematics. There may be couple of factors which lets learners perform below expectations and one of the factors could be due to the teaching learning practices in the classroom. Therefore, the use of games incorporated with manipulatives is seen as one of the alternatives which can change the learner's perception towards mathematics from negative to positive and enhance learning achievement.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter explains the kind of methodology and instruments used in answering the research questions. It also presents the demographic profile of the sample group, validity and reliability of the instruments. The data collection procedures and analysis are also discussed in detail.

3.1 RESEARCH DESIGN

In this study, the researcher used mixed methodology incorporating both aspects of qualitative and quantitative approaches to examine the grade six Bhutanese learners' learning achievement and perception towards the use of games incorporating manipulatives to teach geometry. Venkatesh, Brown, and Bala (2013) defined that, the mixed method research is an approach that integrates quantitative and qualitative research methods in one single research study. Almalki (2016) described mixed methodology as a type of research in which researchers combine elements of both qualitative and quantitative research approaches to gather in-depth information. Guest and Namey (2015) also described mixed method research as an integration of quantitative and qualitative data collection and data analysis procedures in a single research.

The pretest-posttest was used to collect quantitative data to determine learning achievement, while structured observation and structured interview were used to collect qualitative data to identify students' perception towards the use of games incorporating manipulatives. Figure 3.1 shown below describes the research design of the study.

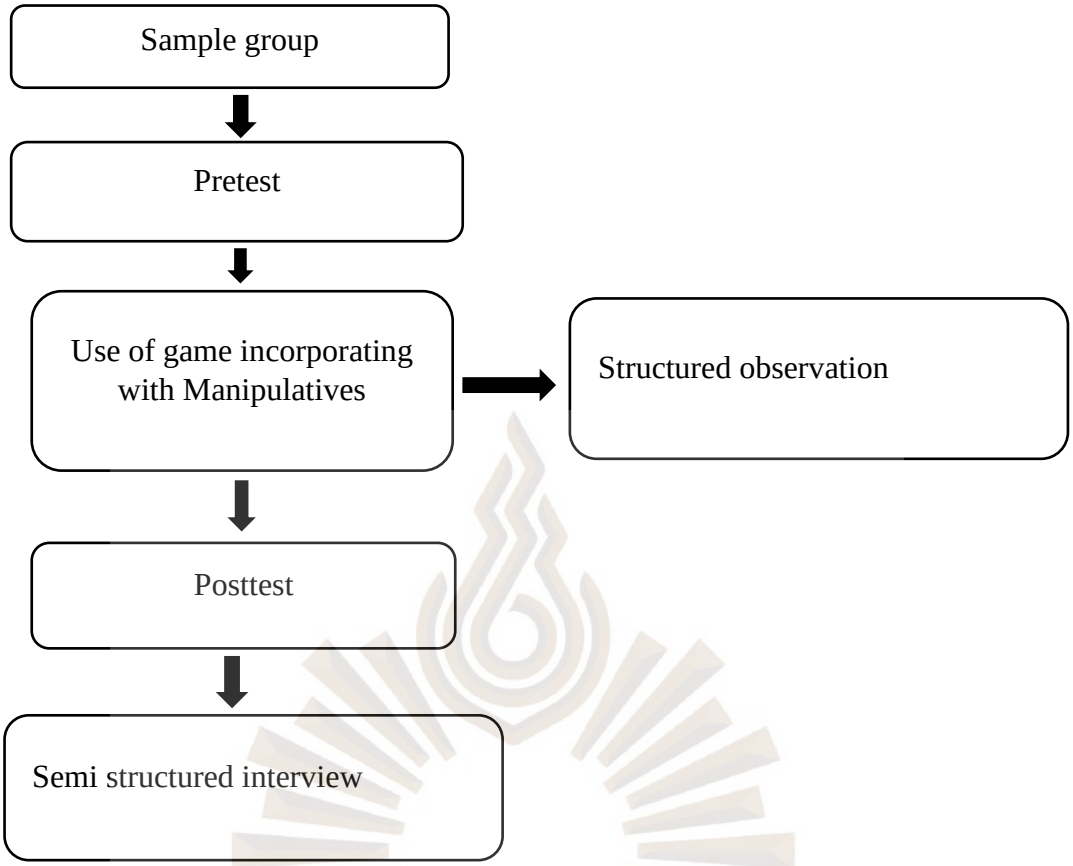


Figure 3.1 Research design of the study

3.2 POPULATION AND SAMPLE OF THE STUDY

The population of the study consisted 56 students (2 sections of 28 students) studying in grade 6 in one of the Lower Secondary Schools in Trashiyangtse district in Eastern Bhutan. The researcher adopted intact sampling method to select a sample group of one section that consisted of 28 mixed ability students. Their age ranged from 12 to 14 years. There were two sections of grade six in the research school. To avoid bias in recruiting the sample group, the researcher requested the principal and randomly picked a paper which had the labels of two grade six sections. The detail of the research participants is as shown in the Table below:

Table 3.1 Demographic profile of the research participants

Gender	Male	Female	Total
Percentage	12	16	28
Age group	12-14	12-14	

3.3 RESEARCH INSTRUMENTS

In this study, researcher used qualitative and quantitative instruments to minimize the inadequacies and strengthened in the research outcome. The key instruments used for data collection were lesson plans, achievement test, structured interview and structured observation.

3.3.1 Instructional Instrument

Lesson Plans

A lesson plan is the instructor's road map of what students need to learn and how it will be done effectively during the class time (Mallick, n.d.). A total of 4 lesson plans of 100 minutes each were used for this study. All the lessons were planned integrating different games incorporating manipulatives for teaching the sample group. Each lesson was taught for a duration of 100 minutes. The researcher taught two periods in a week for a duration of 4 weeks.

3.3.2 Quantitative Data Collection Instrument

Pretest and Posttest

The learning achievement test was developed based on the learning outcomes as outlined in the Royal Educational Council (REC) curriculum framework. It was developed as per the guidelines of Bhutan Council for School Examination Assessment (BCSEA). Learning achievement test was comprised of 5 marks multiple choice answer

questions, 5 marks true or false question and 10 marks short answers type questions for pretest and posttest. Learning achievement test is a vital instrument in school assessment and has great importance in determining instructional growth and growth of the students in the subject area (Johnson, 2014). Pretest and Posttest on “Geometry – 3 D shapes” were conducted to compare the learning achievement of the sample group. Pretest determined the level of their learning before the treatment. After implementing the treatment, posttest was conducted on the same items to examine the significant difference in the learning achievement of students in the pretest and posttest. The same test items were used for pre and post evaluation to ensure consistent evaluation.

3.3.3 Qualitative Instruments

Structured Interview

Structured interview was carried out to find the perception of grade six learners towards the use of games incorporating manipulative in teaching geometry. The structured interview was composed of 8 questions (Refer Appendix E) which were adopted from Tashi (2019). The structured interview was conducted with individual learners and responses were recorded which was later analyzed using a thematic analysis method (discussed in chapter 4).

Structured Observation

Participant observation is the process allowing researchers to study about the activities of the participants under study in the normal setting through observing and participating in those activities (Kawulich, 2005). Observation in a research is a method of collecting data through recording the participants behavior during the activity in a systematic way (Dodiya, Kapadiya, & Malvaniya, 2014). The observations were carried out by experienced peer teacher in all four treatment lessons of the researcher. The structured observation had 10 observation statement which were adopted from Dema (2018). In this study, structured observation was carried out to back up the themes

derived from structured interview and make it more reliable and authentic to measure learner's perception towards the use of games incorporating manipulatives.

3.4 VALIDITY AND RELIABILITY OF THE RESEARCH INSTRUMENTS

3.4.1 Content Validity

Instruments were validated by two experts from Bhutan: A principal from one of the Lower Secondary schools, a senior teacher from one of the primary schools 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 item between 0.67 and 1.00 was considered accurate and acceptable. On other hand the value below 0.67 indicated that the items needed to be rephrased as per the experts' suggestions and feedback.

The experts used IOC to validate all the research instrument as discussed below:

1) All four lesson plans were rated as +1 by the experts which affirmed that the items were congruent to the research objectives. Hence, the items were considered valid for the study. (Refer to Appendix H).

2) The IOC ratings for the test questions were rated +1 by all the experts which indicated that the test items were congruent and valid for the pretest and posttest (Refer to Appendix D).

3) The IOC for structured interview were above 0.67 which confirmed that the items were valid for the study (Refer to Appendix F).

4) The IOC for the structured observations were rated above 0.67 that showed that the items were congruent and valid for the study (Refer to Appendix J).

Therefore, all the instruments used for data collection were found valid and authentic in conducting the study as per the research objectives.

3.4.2 Reliability

To check the reliability of the achievement test, the researcher conducted pilot test consisting of 5 marks multiple choice answer questions, 5 marks true or false questions and 10 marks short answers type questions with a section of 6th grade consisting of 37 students from one the schools in Trashiyangtse district, in Bhutan. Kuder- Richardson formula (KR-20) was applied to find out the reliability coefficient of the learning outcome test. The KR-20 coefficient was required to be equal to or greater than 0.70 for the instruments to be reliable.

To determine the reliability of the test questions for pretest and posttest, reliability test was conducted to 30 grade six learners studying in different school from research school in Trashiyangtse district, Bhutan. Kuder-Richardson coefficient (KR-20) was applied to calculate the reliability test items. The KR-20 coefficient obtained was 0.71 (Refer to Appendix O) which was greater than 0.70. Thus, the coefficient 0.71 revealed that the test items were reliable.

3.5 DATA COLLECTION PROCEDURE

3.5.1 Ethical Consideration

3.5.1.1 Approval

The researcher sought an approval from the Ministry of Education in Bhutan, principal and concerned subject teacher of the research school before the actual data collection began. Since research participants were below the legal age, the parents of every study participant were notified and consent letter was obtained to avoid the violation of research participants rights during the study (Refer appendix P).

3.5.1.2 Anonymity of the Participants

The anonymity and confidentiality of the participants' opinion and learning achievement records were taken care through number system. Research participants identity were not exposed in the study but were coded with numbers as an alternative to ensure confidentiality. All data were destroyed upon the completion of the study.

3.6 DATA ANALYSIS

The data analysis was done in two broad areas:

Test score analysis to examine the effects of using games incorporating manipulatives on learning achievement in learning geometry.

Thematic analysis of structured interviews and structured observation to examine the learner's perceptions toward the use of games incorporating manipulatives in learning geometry.

3.6.1 Analysis for Learning Achievement

The data gathered from pretest and posttest data were analyzed using Wilcoxon signed rank test since the research participants were less than 30. The comparison was done based on mean, standard deviation, significant value and test normality. The analysis examined the learning achievements of the participants on the use of games incorporating manipulatives in geometry.

3.6.2 Analysis for Learning Perception

The data was collected through individual structured interview and structured observation. The information gathered were analyzed through a thematic analysis adopted from Braun and Clarke (2016). This analysis examined the perception of participants towards the use of games incorporating manipulatives in geometry.

CHAPTER 4

DATA ANALYSIS

In this chapter, the researcher presents the crucial findings on the use of games incorporating manipulatives in geometry for grade six students. The researcher involved only one sample group for this research. The data were collected conducting pretest before the treatment and posttest after the treatment to study the effect of using games incorporating manipulatives in teaching geometry in grade six. The researcher also conducted structured interview and structured observation from the same sample group to find out students' perception towards the use of games incorporating manipulatives in learning geometry.

The researcher presents data collected from pretest and posttest as quantitative data and the data collected from structured interview and structured observation as qualitative ones.

4.1 QUANTITATIVE DATA ANALYSIS

4.1.1 Analysis of Quantitative Data

The first research question of the study was: Would the use of games incorporating manipulatives had an effect on the learning achievement of grade six Bhutanese students in geometry? To answer this question, pre-test and a post-test were executed to the sample group. A comparative statistical analysis was done using Wilcoxon signed rank test by comparing in terms of mean, standard deviation, significance value. The comparison was done 'within the group' by comparing the pretest and posttest scores of the sample group. The statistical analysis was done using Wilcoxon signed rank test because the number of research participants in the study were

less than 30. Wilcoxon signed rank test is a non-parametric statistical test which compares the difference between each pair and analyzes the differences (Adams, 2019).

4.1.1 Data Analysis of Pretest and Posttest

The table 4.1 displayed the improvement of individual learners. The difference in the pretest and posttest score ranged from the lowest 1.5 and the highest being 12 marks. The maximum improvement was shown by student 1 with difference of 12 marks and least improvement was shown by student 13 with the difference 1.5 marks.

Table 4.1 Improved scores of individual learners after the treatment

Student	Pretest/ 20	Posttest/ 20	Difference	Rank	Positive Rank	Negative Rank
1	4	16	12	28	28	-
2	5	13	8	20	20	-
3	9.5	15	5.5	12.5	12.5	-
4	5	15.5	10.5	26	26	-
5	4.5	13	8.5	23	23	-
6	4	12.5	8.5	23	23	-
7	4	15.5	11.5	27	27	-
8	6	12.5	6.5	16.5	16.5	-
9	5	11.5	6.5	16.5	16.5	-
10	6	12	6	14.5	14.5	-
11	6.5	13.5	7	18	18	-
12	6.5	14	7.5	19	19	-
13	9.5	11	1.5	1	1	-
14	6	10	4	4.5	4.5	-
15	8	11.5	3.5	2.5	2.5	-
16	8	12.5	4.5	6.5	6.5	-
17	6	14.5	8.5	23	23	-
18	7	15.5	8.5	23	23	-
19	5.5	14	8.5	23	23	-
20	7.5	11	3.5	2.5	2.5	-
21	9.5	14.5	5	9.5	9.5	-
22	6	11	5	9.5	9.5	-
23	5	9	4	4.5	4.5	-
24	7	11.5	4.5	6.5	6.5	-
20	7.5	11	3.5	2.5	2.5	-
21	9.5	14.5	5	9.5	9.5	-

Table 4.1 Improvement scores of individual learners after the treatment (Cont.)

Student	Pretest/ 20	Posttest/ 20	Difference	Rank	Positive Rank	Negative Rank
25	7	12.5	5.5	12.5	12.5	-
26	7.5	13.5	6	14.5	14.5	-
27	5.5	10.5	5	9.5	9.5	-
28	6.5	11.5	5	9.5	9.5	-

The data collected from the pretest and posttest scores of the sample groups were used to examine the learning achievement in geometry of grade six students before and after the use of games incorporating manipulatives. The comparison of pretest and the posttest were conducted within the same group as shown in table 4.2.

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

Test	N	Mean	SD	Mean difference
Pretest	28	6.33	1.59	12.78 – 6.33 = 6.45
Posttest	28	12.78	1.84	

Table 4.2 clearly illustrated the results of the pretest and posttest comparison in terms of mean and standard deviation. The result revealed that the mean score in the pretest was 6.33 and posttest mean score was 12.78 making the mean difference of 6.45. This finding strongly supported the execution of games incorporating manipulatives. The standard deviation of pretest and posttest were 1.59 and 1.84 respectively as presented in the table above. The difference of standard deviation resulted 0.25 higher than the pretest signifying the learners scores deviating from the mean which eventually explains the difference in the degree of impact of the treatment with the learners.

According to the data, it revealed that the posttest scores of the sample group were comparatively higher than the pretest scores. Likewise, the mean difference of the posttest was found significantly higher than the pretest, as shown in figure 4.1.

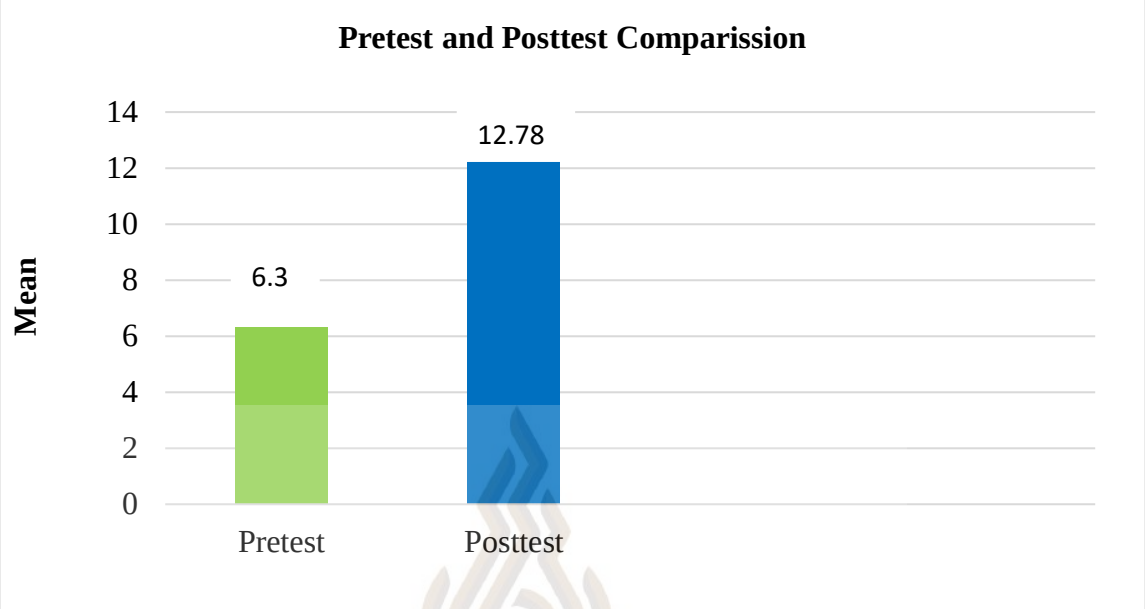


Figure 4.1 Illustration of the mean of the pretest and posttest scores of the sample group.

In figure 4.1 the green bar represented the mean in the pre-test score and blue one represented the mean in the posttest score. The comparison disclosed that the mean in the pretest was comparatively lower than the mean in the posttest. That was a very strong indication that the use of games incorporating manipulatives contributed in enhancing learning achievement.

Table 4.3 Wilcoxon signed rank test

Rank of Wilcoxon		N	Mean Rank	Sum of Ranks	Sig. (2 tailed test)
Pretest – Posttest	Negative Ranks	0^a	0.00	0.00	0.001
	Positive Ranks	28^b	14.50	406.00	
	Ties	0^c			
	Total	28			

a. Posttest score < Pretest score

b. Posttest score > Pretest score

c. Posttest score = Pretest score

The table 4.3 illustrated, there were 28 research participants who performed the achievement test. In contrast to the pretest, every learners' score was improved in the posttest. Thus, it was concluded that none of the learners were in negative rank category which figured to 0 negative rank. On the other hand, every learner was in the positive rank category which figured positive rank to 28. There were no ties in the pretest and the posttest scores which figured ties to 0. Wilcoxon signed rank test displayed in the table above signified the significance value of .001. Thus, it was concluded that there was significant increase in the posttest scores. Therefore, the result supported that the implementation of games incorporating manipulatives had a positive effect in enhancing the learning achievement of grade six students.

The diagram below displayed the number of students improved in different score range after the treatment. The score range of students were expressed in percentage in order to examine in which score range maximum learners fall and vice versa.

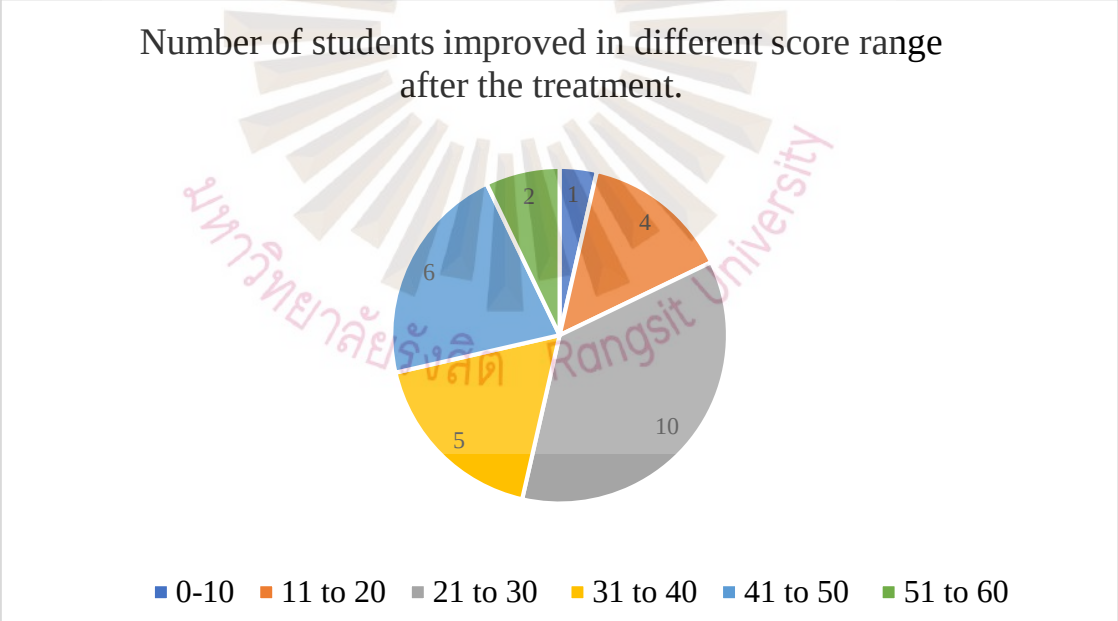


Figure 4.2 Displaying number of students improved in different score range after the treatment.

The maximum of 10 out of 28 learners improved their scores within the range of 21 to 30%. Six out of 28 learners improved their scores in the range of 41 to 50%. Five out of 28 learners improved their scores in the range of 31 to 40%. Four out of 28

learners improved their scores in the range of 11 to 20%. Two out of 28 learners scored in the range of 51 to 60% and 1 out of 28 learners scored in the range of 1 to 10%. The improvement was seen in almost all the students though the degree of improvement varied amongst the students. This showed that the use of games incorporating manipulatives contributed in improving the learning achievement of the grade 6 learners in learning geometry.

4.2 QUALITATIVE DATA ANALYSIS

The second research question was: What were the perception of grade six Bhutanese learners towards the use of games incorporating manipulatives in learning geometry? The data were collected through structured interview and structured observation in order to answer the question.

4.2.1 Structured Interview

One of the instruments used by the researcher to examine the fulfillment of learning perception was structured interview. The interview conducted were recorded and then the researcher applied Delahunt and Maguire (2017) six steps thematic analysis.

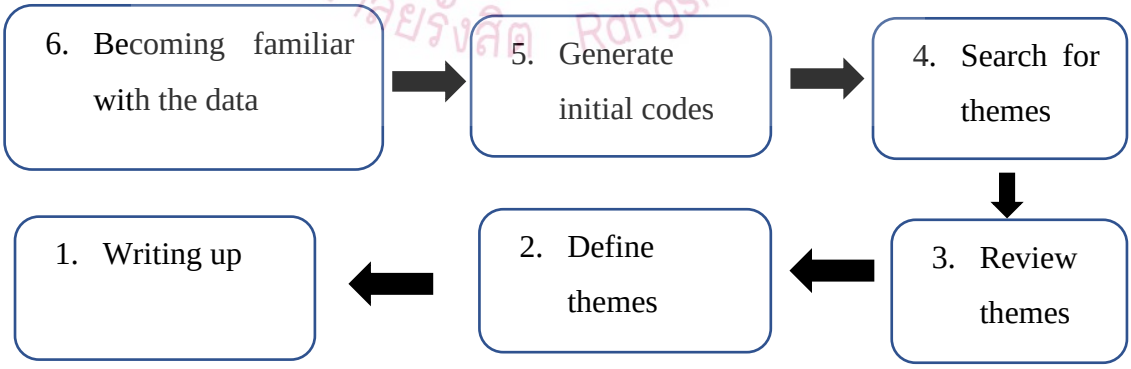


Figure 4.3 Process of thematic analysis.

Source: Adopted from Braun & Clarke, 2016

With these six steps of process the researcher derived following themes from semi structured interview: 1) Enjoyment, 2) Self Confidence, 3) Learning through collaboration and 4) Motivation for Learning. The themes are discussed as following:

4.2.1.1 Enjoyment

According to the responses transcribed based on above two questions, learners revealed that they enjoyed the geometry lessons in mathematics with the use of games incorporating manipulatives. Almost every learner mentioned about the enjoyment and the fun they had while learning the lesson.

> "I enjoyed the mathematics classes as there was group discussion and games being played. In other normal classes teachers keep on teaching and we keep on listening to the teacher" (Student 2).

> "I enjoyed the Mathematics class because we played games using many things. We usually learn mathematics in similar ways but we don't play games with lots of materials." (Student 27).

The above extracts clearly depicted that the learners enjoyed during the lesson with the implementation of games incorporating manipulatives. Most of the learners expressed that, since they enjoyed the activities carried out during the sessions it was easy for them to grasp the intended concepts and skills as they were able to solve the problems posed.

4.2.1.2 Self Confidence

With the use of games incorporating manipulatives in geometry, it was revealed that, every learner was engaged in the group activities as the works were delegated among every group member. It kept them focused on the particular topic when they discussed in the group and completed the assigned task. Most of the learner stated that they gained self-confidence as group members contributed ideas related to the topic

during the discussion. The manipulatives provided during the activities supplemented in advancing their discussion to higher level as it modeled and simplified abstract geometry concepts. Thus, it helped them understand the concept and gained confidence while presenting to the whole class.

> "We discussed and explored in a group regarding the problems with the help of manipulatives. Therefore, we did not find any difficulties while presenting our work to the class" (Student 14).
> "It made me more competent as I got an opportunity to discuss with friends and ask doubt to the teacher. We were able to learn more through fun" (Student 4).

> "Yes, it helped me to improve my self-confidence as I was able to listen to friends' ideas and share my idea to solve problems" (Student 22).

The extracts disclosed that, students got ample opportunities to discuss among the friends in a group. The manipulatives helped discussion them to gather information while solving the assigned problem. That made them comfortable in learning and gained self- confidence.

4.2.1.3 Learning through Collaboration

Use of games incorporating manipulatives in teaching geometry promoted learning through collaboration as the learners worked in a group and solved the problems. It helped in maintaining positive relationship among the learners as they respected ideas contributed by members.

> "The most important experience that I gained was the corporation as everyone in the group were corporative which make learning fun" (Student 16).

> **"**I enjoyed learning with the use of games incorporating manipulatives as my group was very interactive and corporative to solve the problems" (Student 5).

> "I enjoyed learning geometry through use of games incorporating manipulatives as we had to do discussions and later, I found that we learn better when there is a platform to discuss" (Student 12).

With the extracts mentioned above, it is clear that the learners discussed ideas in group and worked collaboratively to fulfill the defined and common objectives. The use of games incorporating manipulatives fostered in working collaboratively among the group members. The learning environment was conducive as they were provided with the required manipulatives, sufficient time and group members who supported one another to solve the problems.

4.2.1.4 Motivation for Learning

According to the responds collected in the structured interview, almost all the learners were motivated to learn with the use of games incorporating manipulatives. Every student wants to learn other mathematics topics through the use of game incorporating manipulatives.

> "We discussed in a group and later presented our work to the class. When different groups presented their work to the class it created situation where we listened to the ideas of different groups. Later, we compared their ideas with our idea which helped us to think in different ways to learn better. The comparison helped us to come up with one conclusion with clear concept of the topic which motivated me" (Student 12).

> "I would like to learn other mathematics topics through the use of games incorporating manipulatives because learning through games and manipulatives encouraged me to solve more problems as it is interesting after understanding the concept" (Student 1).

The above extracts clearly indicated that the learners were motivated as they used their prior knowledge to solve the problems. It also created a platform where they experimented the skills gained in a trial and error method during the course of discussion to solve assigned problems with the help of manipulatives. Therefore, the learners were motivated to learn concepts with the use of games incorporating manipulatives.

All four themes interpreted above supported that the use of games incorporating manipulatives was an effective technique in the process of teaching and learning geometry in Mathematics subjects. It made the classroom situation very conducive where learners used manipulatives to simplify the abstract concepts (example: planes of symmetry, cross-section). Learners interacted and explored in a group based on their prior knowledge to solve the problems. Therefore, the researcher concluded that, learners had a positive perception towards the use of games incorporating manipulatives in teaching geometry.

4.2.2 Structured Observation

The researcher conducted four classes and all four classes were observed by a peer teacher to answer second research question. The main purpose of structured observation in this study was to evaluate whether the themes derived from structured interview tally with the observation statements. The information collected were from two dimensions: structured interview (learners' response) and structured observation (behavior observation observed by peer teacher). Structured Observation were analyzed using thematic analysis. The researcher compared and contrasted the themes derived from structured interview with the observation statements in structured observation and found that the observation statement had strongly supported the themes derived from structured interview. Moreover, the researcher analyzed the suggestions and feedbacks provided by the peer teacher in one core theme "Classroom Participation"

4.2.2.1 Classroom Participation

Learners actively participated in the classroom activities with lots of enthusiasm for learning the topics. Most of the learners actively volunteered to answer the questions. Learners discussed the assigned task in the groups to come up with solutions after exploring through much discussions with the help of manipulatives.

> "Learners were engaged and participated thoroughly with lots of interest in the topic that they were taught" (Classroom Observation 1).

> "The learners were motivated and they participated actively in the process of learning" (Classroom Observation 2).

The excerpts supported that the use of games incorporating manipulatives in teaching geometry in grade six students was effective and had an impact to the learners.

This research study was guided by two questions:

1) Would the use of games incorporating manipulatives have an effect on the learning achievement of grade six Bhutanese students in geometry?

2) What were the perception of grade six Bhutanese learners towards the use of games incorporating manipulatives in learning geometry?

In summary, this chapter discussed the data analysis of pretest and posttest which evidently concluded that the use of games incorporating manipulatives enhanced the learning achievement of grade six students in learning geometry. The data analyzed from structured interview and structured observation resolved that the learners had positive perception towards the use of games incorporating manipulatives in learning geometry. The learners enjoyed and motivated in conducive learning environment created by the use of games incorporating manipulatives. Therefore, the analysis of pretest and posttest, semi structured interview and classroom behavior observation

unfolded the significant result towards learning geometry through games incorporating manipulatives.

CHAPTER 5

CONCLUSION, DISCUSSION AND RECOMMENDATION

This chapter discusses the findings and the implications of the results analyzed. In this chapter, the relevant literatures were reviewed to support the findings of the study. In addition, the researcher proposed some recommendations which would be beneficial while exploring various classroom teaching and learning approach specifically in teaching and learning mathematics.

5.1 CONCLUSION

This study was guided by two main questions:

1) Did the use of games incorporating manipulatives have an effect on learning achievement of grade six Bhutanese student in geometry?

2) What was the perception of grade six Bhutanese students towards the use of games incorporating manipulatives in learning geometry?

The pretest and posttest were used to collect quantitative data which responded the first research question. The structured interview and structured observation were used to collect qualitative data which answered the second research question. The following conclusions were drawn from the results of data analysis.

5.1.1 The Result of Test Score Analysis

The first question of this research was: Did the use of games incorporating manipulatives have an effect on learning achievement of grade six Bhutanese student in geometry? To answer this question, pretest and posttest were conducted with the sample

group on same items to find the learning achievement of the students before and after the implementation of games incorporating manipulatives on the topic Geometry. (Sample learning outcome test is shown in Appendix E)

A comparative statistical analysis was done using Wilcoxon signed rank test within the sample group to see the difference in the level of achievement between pretest and posttest. The mean scores of pretest and posttest were 6.33 and 12.78 respectively. The mean differences between pretest and posttest was 6.45. The results of the analysis unveiled that the mean score of the posttest was higher than the mean score of the pretest as shown in Table 4.2 in Chapter 4. The significance value (p) was 0.01 which proved that there was statistically significant increase in the scores of posttests than in pretest of the sample group. Therefore, the first question of this research was answered as the learning achievement of grade six Bhutanese learners' in geometry were yielded better when taught with the use of games incorporating manipulatives.

It was evident that almost all the learners improved in their scores in posttest as compared to the pretest. Thus, it has evidenced that there is a positive effect of using games incorporating manipulatives on learning achievement in geometry of grade six Bhutanese students. The first research hypothesis which specified that there would be an improvement in the learning achievement of the learners after implementing games incorporating manipulatives had been tested with positive result.

5.1.2 The Result of the Structured Interview

The structured interview was conducted with individual learner to respond the second research question: What were the perception of grade six Bhutanese students towards the use of games incorporating manipulatives in learning geometry? The data collected was analyzed through thematic analysis and it was evident that learners had positive perception towards the use of games incorporating manipulatives in learning geometry. The learners enjoyed during the teaching learning session as the classroom environment was conducive with lots of discussions and interactions among the friends in a group. In the interview, the learners articulated about their learning experiences in

lessons carried out with the use of games incorporating manipulatives. Most of the learners shared that, they got an opportunity to explore and experiment the skills that they gained from the lessons imparted. Thus, it created the platform where they learnt through discussions, hands on experiences and games which contributed in achieving better academic performance in Mathematics subject. That ultimately fostered learners to build positive perception towards the use of games incorporating manipulatives in learning geometry.

Individual learners responded that all lessons conducted during the period of data collection were interesting as learners were exposed to games in every session and learnt through hands on practice as the manipulatives were provided during the activities. Learners were active throughout the lessons and were able to solve problems in given period of time through rigorous discussion in the groups. learners maintained positive relationship among during the activities and worked collaboratively in a group to complete the group task. Their active participation helped the researcher to complete the lessons within the time frame. The data compiled from structured interview and after its analysis researcher was convinced and concluded that grade six Bhutanese learners had positive perception towards the use of games incorporating manipulatives in learning geometry. Hence, it answered the second research question and supported the second research hypothesis.

5.1.3 The Result of Structured Observation

Structured observation was another instrument used by the researcher to answer second research question: What was the perception of grade six Bhutanese students towards the use of games incorporating manipulatives in learning geometry? The data acquired was analyzed through thematic analysis. The classroom behavior observation was carried out by the peer teacher, a delegated grade six mathematics teacher of a research school.

It was observed that the learners were actively involved in the lesson activities with enthusiasm. Learners volunteered to answer the questions during the question

answer sessions. Learners discussed the assigned task in a group and came up with the solutions which subsequently they presented to the class by taking turn. Learners used their prior knowledge to solve the task through group discussion. Learners explored more with the help of games incorporating manipulatives. Learners listened and followed the instructions correctly and were comfortable to seek help from peers or teacher. The researcher compared and contrasted the themes derived from structured interview with the observation statements in structured observation and found that the observation statement had strongly supported the themes derived from semi structured interview. Moreover, the researcher analyzed the suggestions and feedbacks provided by the peer teacher in one core theme "Classroom Participation"

5.2 DISCUSSION

The study disclosed two major findings. The first finding of this study was the use of games incorporating manipulatives had improved learning achievement of grade six Bhutanese learners in geometry. This was evident with the results compiled from the learning achievement test which displayed the mean difference of 6.45 in pretest and posttest of the sample group. The score of individual students was shown clearly in Figure 4.2 in Chapter 4. With the use of games incorporating manipulatives approach, maximum learners scored higher in posttest than in pretest with the 2-tailed significant value of 0.01. Even the low achievers were able to fetch their marks nearing the mean mark in posttest which lessened the breach between high achiever and the low achiever. Thus, the findings specified that games incorporating manipulatives was effective in teaching geometry to fetch better learning achievement of the learners.

The above finding were in line with the study carried out by Bahrami et al. (2012); Akinsola and Animasahun (2007). Their studies found that, integrating games in teaching mathematics is seen as very important strategy which improved learning achievement and gained positive perception towards mathematics. The games reduced learner's difficulties in learning mathematics as they are offered with the platform where they learn it by doing which makes teaching and learning mathematics practical,

expressive and retainable. The finding were also supported by the studies carried out by Kontas (2016) a study conducted to find out the impact of mathematics manipulatives in improving learner's mathematics achievement as well as attitude towards mathematics. In his study it was revealed that mathematics manipulative has a crucial role in imparting mathematics concepts and skills to the learners contributing significant improvement in the learning achievement. It was also confirmed that, the Mathematics manipulatives has greatly impacted in learner's perspective towards Mathematics subject. The claim was supported by the high scores achieved in the posttest as compared to the pretest.

The possible reasons for improvement in the learning achievement was due to the active engagement of the learners during the learning process. In this study learners were fully engaged during the learning session. Learners were given freedom to discuss, share. They enjoyed greater freedom to ask and seek help from teacher as well as from peers which created stress free classroom during the course of solving the problems assigned by the researcher which learners subsequently had to present to the class. Piaget's Theory of Cognitive Development, Lev Vygotsky's Zone of Proximal Development and Constructivism theory, supported this finding of the study. According to these theories, the optimum learning take place when learners learn it by doing using the prior knowledge gained from the other knowledgeable person. These theories have highlighted mainly on active engagement of learners in the process of learning.

The second major finding of the study was that learners had positive perception towards the use of games incorporating manipulatives in learning geometry. The data were collected through structured interview which was conducted at the end of experiment and structured observation observed by the peer teacher during all four teaching learning sessions. The data collected were analyzed by using thematic analysis. The result compiled from structured interview was strongly supported by the result collected from the structured observation. The results revealed that learners were highly positive towards the use of games incorporating manipulatives. Almost all the learners enjoyed learning through use of games incorporating manipulatives throughout the

learning session. Learners learnt with fun, curiosity which made the classroom safe and conducive for learners.

Makri and Vlachopoulos (2017) stated that, the games were the powerful educational method which established conducive learning environment through which learners obtained knowledge and skills across the subjects. Games are the teaching method enjoyed by learners and at the same time it encouraged learners to participate actively and collaboratively. When such learning environment were provided the learners get an opportunity to develop critical thinking, take accountability for decision making, problem solving. The results of this study were also supported by the findings of Ku et al. (2014) who claimed that, the infusion of games not only had positive impact in harvesting better results but also improved the confidence of the learners in mathematics. The studies carried out by Bahrami et al. (2012) stated that, the group of learners in Instructional games achieved significantly high score than the group of learners in traditional teaching method.

Similarly, Larbi and Mavis (2016) stated that manipulatives provided a meaningful learning experiences helping learners to construct their own mathematical ideas and promote Inquiry- based learning skills. Hence, the use of manipulatives in the process of teaching and learning contributed longer retention which enhance learners' motivation to learn mathematics ultimately leading to achieve improved test achievements towards the end.

The possible reasons for such findings could be due to conducive and friendly classroom atmosphere created by the use of games incorporating manipulatives and at the same time the active involvement of the learners in the learning activities. The other possible reason for acquiring positive perception towards the use of games incorporating manipulatives could be due to the use of different instructional games and mathematics manipulatives while imparting the lessons. The learners were found very curious while doing the activities which was a clear indication of how learners were motivated with the use of games incorporating manipulatives.

5.3 RECOMMENDATIONS

This study aimed to evaluate the effective learning achievement of using games incorporating manipulatives in geometry for grade six students in Bhutan. Thus, the findings of this study revealed that the use of games incorporating manipulatives improved learning achievement of the learners and showed the positive perception towards the use of an approach in learning geometry. Therefore, based on the findings of this study, following recommendations was made and could prove to be valuable and advantageous for better teaching and learning of Mathematics.

5.3.1 Recommendation for Practice

1) Teaching through games incorporating manipulatives had positive impact on learning achievement of the learners. The results from this study showed that the learning achievement of the posttest was higher than the pretest. Therefore, the use of games incorporating manipulatives into daily classroom teaching is highly recommended.

2) Teachers may also try teaching other topics in mathematics using games incorporating manipulatives to make their lessons interesting, and engaging, to enhance learning achievement.

3) Learners showed positive perception towards games incorporating manipulatives in learning geometry. Thus, use of games incorporating manipulatives in daily teaching in the classroom is highly recommended.

4) This study would also help as a reference for Bhutanese researchers to research in related field of studies.

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) Further research may be carried out to study the effectiveness of games incorporating manipulatives in other subjects and other level of education.

2) This study used only few games incorporating manipulatives in few topics. Therefore, further study may be carried out with games incorporating manipulatives with other mathematics topics.

4) Further research can be carried out for longer period of time to make results more reliable and significant.

5) Finally, additional studies can be carried out to investigate the influence of variables like gender, age, level of study, mode of study etc. on games incorporating manipulatives approach used in different learning situations to further expand the knowledge of students' and students' academic achievement.

In conclusion, if the schools implement the use of games incorporating manipulatives, the learners will obtain better achievement in the tests. The use of games incorporating manipulatives contributes active learning engagement as the learners are delegated for certain responsibilities which individual should be accountable during the entire activity. It helps learners to comprehend abstract concepts in a simplified manner since they use manipulatives to explore and go through rigorous discussion to solve the given problem. Thus, the learners learn it hand on practice through which they experiment their learning in trial and error method and the skills and concepts learnt will be retained for longer period of time. Therefore, the use of games incorporating manipulatives will be one of the important approaches to improve learning achievement.

REFERENCES

Aarnos, E., & Perkkila, P. (2012). Early signs of mathematics anxiety? *Procedia - Social and Behavioral Sciences, 46,* 1495-1499. doi:10.1016/j.sbspro.2012.05.328

Adams, H. (2019, April). *Wilcoxon Test.* Retrieved from https://www.investopedia.com/terms/w/wilcoxon-test.asp

Ajai, J. T. (2013). Effects of Games and Simulation Teaching Srategy on Students' LevellingWer-West Local Government Area of Benuestate. *Journal of Studies in Science and Mathematics Education, 3*(6), 25-30. Retrieved from https://www.researchgate.net/publication/313900354_

Akinsola, M., & Animasahun, I. (2007). The Effect of Simulation-Games Environment on Students Achievements in and Attitudes to Mathematics in Secondary Schools. *The Turkish Online Journal of Educational Technology, 6*(3), 113-117. Retrieved from https://files.eric.ed.gov/fulltext/EJ1102638.pdf

Al-Absi, M. M., Nofal, M. B., & Jordan, A. (2010). The Effect of Using Manipulatives on the Mathematical Achievement of the First Grade Students. *Damascus University Journal, 26*(4), 37-52. Retrieved from https://shamra.sy/uploads/documents/document_54357d43cff4c4d0d292d006e45a6fb8.pdf

Aldoobie, N. (2015). ADDIE Model. *American International Journal of Contemporary Research, 5*(6), 68-69. Retrieved from http://www.aijcrnet.com/journals/Vol_5_No_6_December_2015/10.pdf

Allen, A. (2011). *Perceptions of College Students on Successful Strategies for Reducing Mathematics Anxiety* (Unpublished Doctoral dessertation). Walden University, USA.

Almalki, S. (2016). Integrating Quantitative and Qualitative Data in Mixed Methods Research—Challenges and Benefits. *Journal of Education and Learning, 5*(3), 288-293. doi:10.5539/jel.v5n3p288

REFERENCES (CONT.)

Back, J. (2013). *Manipulatives in the Primary Classroom*. Retrieved from Enrich website: https://nrich.maths.org/10461

Bada, S. O. (2015). Constructivism Learning Theory: A Paradigm for Teaching and Learning. *IOSR Journal of Research & Method in Education, 5*(6), 66-70. Retrieved from https://pdfs.semanticscholar.org/1c75/083a05630a663371136310a30060a2afe4b1.pdf

Bahrami, F., Chegini, Z. R., & kianzadeh, A. (2012). A comparison of the effectiveness of game-based and traditional teaching on. *European Journal of Experimental Biology, 6*(2), 2099- 2102. Retrieved from http://www.imedpub.com

Bartolini, M. G., & Martignone, F. (2014). *Manipulatives in Mathematics Education. Encyclopedia of Mathematics Education.* Retrieved from https://link.springer.com/referenceworkentry/10.1007%2F978-94-007-4978-8_93

Bhujel, B. (2012). *An analytical study of the implementation of the Gross National Happiness values in primary schools in Samtse District, Bhutan* (Unpublished Master's thesis). Rangsit University, Thailand.

Bhutan Council for School Examinations and Assessment. (2017). *Competency Based Assessment Classes III and VI Report 2017*. Retrieved from https://www.bcsea.bt

Bhutan Council for School Examinations and Assessment. (2018). *Grades III and VI CBAT 2018*. Retrieved from http://www.bcsea.bt

Bhutan Council for School Examinations and Assessment. (2019). *Grade vi CBAT 2018.* Retrieved from http://www.bcsea.bt

Blazer, C. (2011). Strategies for Reducing Math Anxiety. *INFORMATION CAPSULE Research Services, 1102,* 1-6. Retrieved from https://files.eric.ed.gov/fulltext/ED536509.pdf

Bruan, V., and Clarke, V. (2016). *Thematics Analysis, 12*(3), 297-298. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/17439760.2016.1262613

REFERENCES (CONT.)

Burns, M. (n.d.). *7 Musts for Using Manipulatives.* Retrieved from Scholastic website: http://www.scholastic.com/teachers/article/7-musts-using-manipulatives-0

Curriculum and Professional Support Division. (2005). *Mathematics Curriculum Framework Classes PP-XII.* Thimphu: Author.

Curriculum and Professional Support Division. (2009). *Mathematics Curriculum Framework Classes PP-XII.* Thimphu: Author.

C, S. M., & Jelenec, P. (2011). Separating Implicit Gender Stereotypes regarding Math and Language: Implicit Ability Stereotypes are Self-serving for Boys and Men, but not for Girls and Women. *Journal of Immigrant and minority Health, 64*, 5 - 6. Retrieved from https://link.springer.com/article/10.1007%2Fs11199-010-9924-x

Casad, B. J., Hale, P., & Wachs, F. L. (2015). *Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes.* Retrieved from https://www.frontiersin.org/articles/10.3389/fpsyg.2015.01597/full

Cennamo, K., & Kalk, D. (2019). *Real World Instructional Design.* New York, Vanderbilt Avenue, USA: Routledge.

Chaza, J. (n.d.). *Causes of Mathematics Anxiety among Secondary School Mathematics Learners: A casestudy of a secondary school in Manicaland province, Zimbabwe*. Retrieved from https://www.academia.edu

Choudhary, A., Dogne, N., & Maheshwari, S. (2014, December). *Mathematics and Architecture: Importance of Geometry.* Conference: National Conference on Advances in Mathematical Applications for Engineering & Technology, NCAMAET-2014, India.

Cope, L. (2015). Math Manipulatives: Making the Abstract Tangible. *Delta Journal of Education, 5*(1), 11. Retrieved from http://www.deltastate.edu/PDFFiles/DJE/spring-2015/dje_spring_2015_cope-final.pdf

Crowell, R. (2016). *Explainer: The basics of geometry.* Retrieved from https://www.sciencenewsforstudents.org/article/explainer-basics-geometry

REFERENCES (CONT.)

Deshpande, A. A., & Huang, S. H. (2008). Simulation Games inEngineering Education:A State-of-the-Art Review. *ResearchGate, 19*(3), 399-410. Retrieved from https://www.researchgate

Dema, K. (2018). *The Use of Field Trip on Eighth Grade Bhutanese Students Learning Experience: A qualitative Study* (Unpublished Master's thesis). Rangsit University, Thailand).

Diaz, O. (2014). *4 benefits of 3D modeling for architects and engineers.* Retrieved from http://www.smartgeometrics.com/2014/06/23/4-benefits-of-3d-modeling-for-architects-and-engineers/

Dobson, C. (2012) *Effect of Academic Anxiety on the Performance of Student with and without Learning Disability and How Students can Cope with Anxiety* (Unpublished Master's thesis). Northern Michigan University, Michigan.

Dodiya, P., Kapadiya, J., & Malvaniya, M. (2014). Classroom Observation: A Critical Analysis of Different Methods. *Proceedings of MonTec- 2014 Organised by HGCE,* 393-397. doi:10.13140/RG.2.1.3197.8649

Dolma, P. (2016). *Investigating Bhutanese Mathematics Teachers' Beliefs and Practices in The Context of Curriculum Reforms* (Unpublished Doctoral Dessertation). Queensland University of Technology, Australia.

Dorji, J. (2005). *The Story of Growth and Change in the Bhutanese Education System.* Thimphu: KMT publisher.

Doyle, A. (2018). *What Is a Semi-Structured Interview? The balance carrer*. Retrieved from https://www.thebalancecareers.com/what-is-a-semi-structured-interview-2061632

Dukpa, P. (2015). Bhutanese student's attitude towards mathematics: Findings from a cross-sectional survey of grade six students. *Attitude towards mathematics, 16* (2), 37-52.

Editorial Team. (2013). *What is GBL (Game-Based Learning)?* Retrieved from https://edtechreview.in/dictionary/298-what-is-game-based-learning

REFERENCES (CONT.)

Erturk, E. (2015, October). *Role Play as a Teaching Strategy*. Paper presented at the National Tertiary Learning and Teaching Conference 2015, Tauranga. doi: 10.13140/RG.2.1.4287.9449

Euclid, Heiberg, J.L., & Fitzpatrick, R. (2008). *Euclid's Element of Geometry.* Retrieved from https://b-ok.org/book/681817/01c3ff

Fabiyi, T. R. (2017). Geometry Concepts in Mathematics Perceived Difficult To Learn By Senior Secondary School Students in Ekiti State, Nigeria. *IOSR Journal of Research & Method in Education, 7*(1), 83-90. Retrieved from https://www.iosrjournals.org

Felman, A. (2018, October 26). What to know about anxiety. *Medical News Today*. Retrieved from https://www.medicalnewstoday.com/articles/323454.php

Fitzpatrick, R. (2008). *Euclid's Elements of Geometry*. Retrieved from http://farside.ph.utexas.edu/Books/Euclid/Elements.pdf

Furner, J. M., & Worrell, N. L. (2017). The Importance of Using Manipulatives in Teaching Math Today. *Transformations, 3*(1), 1-25. Retrieved from https://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1013&context=transformations

Fraenkel, J.R. (2012). *How to design and evaluate research in education* (8th ed.). NewYork: McGraw-Hill.

Gerard, M. J. (n.d.). *Types of Math Manipulatives.* Retrieved from https://sciencing.com/types-of-math-manipulatives-12747350.html

Guest, G., & Namey, E. E. (2015). *Public Health Research Methods.* Retrieved from *Sage Publication, inc* website: https://us.sagepub.com/en-us/nam/public-health-research-methods/book237897

Guha, M. (2015). *Dictionary* (Vol. 30). Glasgow: Emerald Group Publishing Limited.

Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2011). The Role of Parents and Teachers in the Development of Gender-Related Math Attitudes. *Health Services and Outcomes Research Methodology, 66*, 3-4. Retrieved from https://link.springer.com/article/10.1007%2Fs11199-011-9996-2

REFERENCES (CONT.)

Gundogdu, M. (2013). *The Impact of Manipulatives on Middle School Special ED Students' Learning Integers.* Retrieved from https://www.worldcat.org

Gyeltshen, D. (2018). *The use of Media to Motivate ESL Students' Learning: A Case Study of Grade Five Bhutanese Students in Mongar District* (Unpublished Master's thesis). Rangsit University, Thailand.

Hamza, E. G., & Helal, A. M. (2013). Maths Anxiety in College Students across Majors: A Cross-Cultural Study. *e-journal of the British Education Studies Association, 5* (2), 58 – 72.

Harris, C. (2009). Meet the New School Board: Board Games Are Back--And They're Exactly What Your Curriculum Needs. *School Library Journal, 55*, 24- 26. Retrieved from https://eric.ed.gov/?id=EJ850549

Hidayah, I., Dwijanto, & Istiandaru, A. (2018). Manipulatives and Question Series for Elementary School Mathematics Teaching on Solid Geometry. *International Journal of Instruction, 11*(3), 649-662 . Retrieved from https://www.researchgate.net

Hom, E. J. (2013). What is Mathematics? *Live Science*. Retrieved from https://www.livescience.com/38936-mathematics.html

Istiandaru, A., Istihapsari, V., Prahmana, I. R. C., setyawan, F. & Hendroanto, A. (2017). *Characteristics of manipulative in mathematics laboratory*. doi:10.1088/1742-6596/943/1/012023

Jameel, H. T., & Ali, H. H. (2016). *Causes of Poor Performance in Mathematics from Teachers, Parents and Student's Perspective.* Retrieved from https://www.researchgate.net

Johnson, A. (2014). Achievement test- Definition, objectives, functions, characteristics. *Nursing Journals and Articles, 9*(1), 3678–3684.

Karim, S., Mohamad, K., & Saman, E. (2010). Vygotsky's Zone of Proximal Development: Instructional Implications and Teachers' Professional Development. *Canadian Center of Science and Education, 3*(4), 237-248. Retrieved from https://eric.ed.gov/?id=EJ1081990

REFERENCES (CONT.)

Kaszkowiak, N. (2017). *Games as teaching method.* Retrieved from Cometa Research website: http://cometaresearch.org/educationvet/didactic-games-as-teaching-method/

Kawulich, B. B. (2005). Participant Observation as a Data Collection Method. *Qualitative Social Research, 6*(2), Art 43. Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/466/996

Khan, A. L. (2015). What is Mathematics-An Overview. *International Journal of Mathematics and Computational Science, 1*(3), 98-101. http://www.aiscience.org/journal/ijmcs

Kirk, D., & MacPhail, A. (2002). Teaching Games for Understanding and Situated Learning: Rethinking the Bunker-Thorpe Model. *Journal of Teaching in Physical Education, 21*, 177-192. Retrieved from https://ulir.ul.ie/bitstream/handle/10344/2946/MacPhail_2002_games.pdf?sequence=2

Koch, I. (2018). *Maths Anxiety: Students, Pre- and In-Service Teachers.* Retrieved from Amsi Choose Mathematics Research website: https://amsi.org.au/wp-content/uploads/2019/01/researchreport4-maths_anxiety_students_and_teachers.pdf

Kontas, H. (2016). The Effect of Manipulatives on Mathematics Achievement and Attitudes of Secondary School Students. *Journal of Education and Learning, 5* (3), 10 – 17. doi:10.5539/jel.v5n3p10

Ku, O., Chen, S. Y., Wu, D. H., Lao, A. C., & Chan, T.-W. (2014). The Effects of Game-Based Learning on Mathematical Confidence and Performance: High Ability vs. Low Ability. *Journal of Education, 17(3)*, 65. Retrieved from https://www.jstor.org/stable/jeductechsoci.17.3.65?seq=1#page_scan_tab_content

REFERENCES (CONT.)

Kurt, S. (2015). *ASSURE: Instructional Design Model.* Retrieved from https://educationaltechnology.net/assure-instructional-design-model/

Larbi, E., & Mavis, O. (2016). The Use of Manipulatives in Mathematics Education. *Journal of Education and Practice*, *7*, 53 -61. Retrieved from https://eric.ed.gov/?id=EJ1126428

Lateef, F. (2010). Simulation-based learning: Just like the real thing. *Journal of emergencies, Trauma, and Schock*, *3*(4), 348-352. doi:10.4103/0974-2700.70743

Lean, J., Moizer, J., Towler, M., & Abbey, C. (2011). Simulations and games. *Sage journal*, *7*(3), 227-242. Retrieved from https://hal.archives-ouvertes.fr/hal-00571951/document

Lee, J., & Jang, S. (2014). A methodological framework for instructional design model development: Critical dimensions and synthesized procedures. *Educational Technology Research and Development*, *62*(6), 743-765. doi: 10.1007/s11423-014-9352-7

Legner, P. (2013). *The Value of Teaching Mathematics.* Retrieved from Mathegon website: https://mathigon.org/downloads/value-of-mathematics.pdf

Leppavirta, J. (2013). The Impact of Mathematics Anxiety on the Performance of Students of Electromagnetics. *Journal of Engineering Education*, *100*(3), 424-443. doi: https://doi.org/10.1002/j.2168-9830.2011.tb00021.x

Lham, K. (2017). *The effect of using manipulatives in teaching mathematics to enhance learning outcome of grade 5 Bhutanese students* (Unpublished Master's thesis). Rangsit University, Thailand.

Lichtman, M. (2013). *Qualitative research in education: a user's guide*. Los Angeles: SAGE Publication.

Liggett, R. S. (2017). The Impact of Use of Manipulatives on the Math Scores of Grade 2. *Brock Education Journal*, *26*(2), 87-101. Retrieved from https://files.eric.ed.gov/fulltext/EJ1160704.pdf

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management 11,* 311-322. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6087017/

REFERENCES (CONT.)

Makri, A., & Vlachopoulos, D. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education, 14*(22), 2-33. Retrieved from https://link.springer.com/article/10.1186/s41239-017-0062-1

Maliki, A. E., Ngban, A. N., & Ibu, J. E. (2017). Analysis of Students' Performance in Junior Secondary School Mathematics Examination in Bayelsa State of Nigeria. *Journal of Home and Community Science, 3*(2), 131-134. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/09737189.2009.11885288

Mallick, H. (n.d.). *What is the Importance of Lesson Planning in Science?* Retrieved from http://www.preservearticles.com/education/what-is-the-importance-of-lesson-planning-in-science/27933

Maloney, E., Schaeffer, M., & Beilock, S. (2013). Mathematics anxiety and stereotype threat: shared mechanisms, negative consequences and promising interventions. *Research in Mathematics Education, 15*(2), 115-128. Retrieved from http://dx.doi.org/10.1080/14794802.2013.797744

Mcleod, S. (2019). *Zone of Proximal Development and Scaffolding.* Retrieved from Simply Psychology Org website: https://www.safepilots.org

Merriam Webster. (1847). *Dictionary* (Vol. 20). USA: Author.

Ministry of Education. (2019). *National Education Policy*. Thimphu, Bhutan: Author.

Morsanyi, K., Busdraghi, C., & Primi, C. (2014). Mathematical anxiety is linked to reduced cognitive reflection: a potential road from discomfort in the mathematics classroom to susceptibility to biases. *US National Library of Medicine, 10*(31), 2-13. doi:10.1186/1744-9081-10-31

Moyer, P. S. (2002). Are we Having Fun Yet? How Teachers Use Manipulatives to Teach Mathematics. *Educational Studies in Mathematics, 47,* 175-197. Retrieved from https://digitalcommons.usu.edu

Musselman, M.-L. (2014). *The effect of game-based learning on middle school students' academic achievement* (Master's thesis). Retrieved from https://scholarworks.uni.edu/cgi/viewcontent.cgi?article=1214&context=grp

REFERENCES (CONT.)

National Center of Intensive Interaction. (n.d.). *Principles for Designing. Washington DC, America: American Institute for Research.* Retrieved from https://intensiveintervention.org/sites/default/files/Princip_Effect_Math_508.pdf

National Council of Bhutan. (2016). *A Review Report om the Quality of Education.* Retrieved from https://www.nationalcouncil.bt/assets/uploads/files/Final%20Education%20Report%20-%202016-Special%20Committee-18th%20Session.pdf

Olubokola, A. (2015). An Investigation of Difficult Topics in the Senior Secondary School Mathematics Curriculum as Perceived by Student Teachers. *American Journal of Educational Research, 3*(7), 844-848. doi: 10.12691/education-3-7-7

Petty, J. (n.d.). *What is 3D Modeling & What's It Used For?* Retrieved from https://conceptartempire.com/what-is-3d-modeling/

Piaget, J., & Cook, M. (1952) *The origins of intelligence in children.* Retrieved from https://psycnet.apa.org/PsycBOOKS/toc/11494

Packenham, P. S., Bolyard, J. J., & Spikell, M. A. (2002). *What are Virtual Manipulatives, 8*(6), 372-377. Retrieved from https://www.researchgate.net

Plass, J. L., Homer, B. D., Kinzer, C. K., & Ken, P. (2015). Foundations on Game-Based learning. *Educational Psychologist, 50*(4), 258-283. doi: 10.1080/00461520.2015.1122533

Pradeep, R. (n.d.). *A Study of Mathematics Anxiety Amongst Primary* (Unpublished Master's thesis). University of Amsterdam, Netherland.

Rivera, M. (2016). *Is Digital Game-Based Learning The Future Of Learning?* Retrieved from https://elearningindustry.com/digital-game-based-learning-future

Russell, D. (2018). *What Is Geometry?* Retrieved from https://www.thoughtco.com/what-is-geometry-2312332

Sara, H., & Aida, M. (2014). The Effect of Anxiety and Emotional Intelligence on Students' Learning Process. *Journal of Education & Social Policy, 1*(2), 115-122. Retrieved from http://jespnet.com/journals/Vol_1_No_2_December_2014/16.pdf

REFERENCES (CONT.)

Schoenherr, D. M. (2015). *Mathematics Anxiety and Coping Strategies* (Doctoral dessertation). Retrieved from https://guides.baker.edu/c.php?g=303165&p=2022831

Shiel, W. C. (2018). *Medical Definition of Anxiety.* Retrieved from Medicine net website: https://www.medicinenet.com/script/main/art.asp?articlekey=9947

Sidiqi, N. (2017). *Effective Strategies to Reduce Math Anxiety in Teachers and Students (*Master's thesis). Retrieved from https://tspace.library.utoronto.ca

Silva, G. C. (2019). *Anxiety: The Perspectives and Stigmas That Come With It* (Master's thesis). Retrieved from https://www.researchgate.net/publication/331971484_Anxiety_The_Perspectives_and_Stigmas_That_Come_With_It_Anxiety

Sokolowski, M. H., & Ansari, D. (2017). *Who Is Afraid of Math? What Is Math Anxiety? And What Can You Do about It?* Retrieved from Frontiers for Young Mind website: https://kids.frontiersin.org/article/10.3389/frym.2017.00057

Somia, A. (2010). *The effects of Anxiety On Students' Achievement The case of third year LMD students: Department of English University of Constantine.* Retrieved from https://bu.umc.edu.dz/theses/anglais/ABD1139.pdf

Sushmita, S. D. (2012). *A Study of Mathematics Curriculum for School Education.* Retrieved from http://www.ncert.nic.in/pdf_files/17.Mathematics%20Curriculum%20for%20School%20Education%20_16.12.pdf

Szücs, D., Carey, E., Hill, F., & Devine, A. (2016). *The Relationship Between Maths Anxiety and Maths Performance.* Retrieved from https://www.cne.psychol.cam.ac.uk/the-relationship-between-maths-anxiety-and-maths-performance

Takehiro, H. (2015, June). *A Study on the Type of School during the Dawn of Modern Education in Bhutan.* Annual International Conference of the Bulgarian Comparative Education Society. Sofia, Bulgaria.

REFERENCES (CONT.)

Tashi. (2018). The Use of Role - Plays to Reduce ESL Students' Speaking Anxiety: A Case Study of Grade Six Bhutanese Classroom (Unpublished Master's thesis). Rangsit University, Thailand.

Taylor, R. W. (2018). *Is There a Significant Correlation Between Student Self-Efficacy.* (Unpublished Doctoral Dissertation). Northern Kentucky University, United States.

Teed, R. (n.d.). *Game-Based Learning. Connecting Theory to Classroom Practice.* Retrieved from https://serc.carleton.edu

The Guardian. (2019). *Maths anxiety' causing fear and despair in children as young as six.* Retrieved from https://www.theguardian.com/education/2019/mar/14/maths-anxiety-causing-fear-and-despair-in-children-as-young-as-six

Thiel, O., & Jenssen, L. (2018). Affective-motivational aspects of early childhood teacher students' knowledge about mathematics. *European Early Childhood Education Research Journal., 26*(4), 2-24. doi:10.1080/1350293X.2018.1488398

Tobgay, S. (2014). *Education System in Bhutan - Past, Present and Future A Reflection.* Retrieved from http://www.judiciary.gov.bt/education/EducationCJB.pdf

Udosen, A. E., & Ekpo, U. S. (2016). Instructional Games: Implications for Curriculum and Instruction. *Equatorial Journal of Education and Curriculum Studies, 1*(1), 26. Retrieved from https://www.academia.edu

Umulis, D. M., & Othmer, H. G. (2012). The importance of geometry in mathematical models of developing systems. *Curr Opin Genet Dev*, *22*(6), 547-552. doi:10.1016/j.gde.2012.09.007

Venkatesh, V., Brown, S. A., & Bala, H. (2013). Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems. *Arizona Commerce Authority, 37*(1), 21 - 54. Retrieved from https://arizona.pure.elsevier.com/en/publications/bridging-the-qualitative-quantitative-divide-guidelines-for-condu

REFERENCES (CONT.)

Verkijika, S. F., & Wet, L. D. (2015). Using a brain-computer interface (BCI) in reducing math anxiety: Evidence from South Africa. *Computer and Education, 81,* 113-122. Retrieved from https://www.sciencedirect.com/science/article/pii/S036013151400222X?via%3Dihub

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education, 14*(22), 2-33. Retrieved from https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-017-0062-1

Voigt, E. H., & Dijk, H. W. (2012). *Situational games; a white paper.* Retrieved from media future week website: http://www.mediafutureweek.nl

Webster, N. (2003). Geometry. *Merrium Webster Dictionary* (11th ed.). Springfield, MA: Merrium Webster, Inc.

Wood, D., Bruners, S. J., & Ross, G. (1976). The Role of Tutoring in Problem Solving. *The Journal of Child Psychology and Psychiatry, 17,* 89-100. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1469-7610.1976.tb00381.x

Yilmazera, Z., & Keklikci, H. (2014). The Effects of Teaching Geometry on The Academic. *Procedia-Social and Behavioral Science, 191,* 2355-2358. Retrieved from https://www.sciencedirect.com/science/article/pii/S1877042815027238

Zyga, L. (2013). *Is mathematics an effective way to describe the world?* Retrieved from https://phys.org/news/2013-09-mathematics-effective-world.html

APPENDICES

APPENDIX A

LETTER OF APPROVAL

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

Date: 2 July 2019

Subject: Request for Permission to Collect Data for M. Ed. Theses

Dear Sir/Madam,

Suryadhep Teachers College for the M. Ed. Program in Curriculum and Instruction would like to request your permission for ten M. Ed. candidates to collect data in Bhutan in the period of 29 July 2019 – 1 September 2019. The details of the candidates are shown below:

Sl. No	Name	Research Title	Research School
1	Chhimi Dorji	The Use of Project-based Learning on Understanding Scientific Concepts of Grade VI Bhutanese Students	Tencholing Primary School, Wangduephodrang
2	Buddha Singh Tamang	Application of Content and Language Integrated Learning (CLIL) Approach for English Learning of Secondary School Bhutanese Students	Punakha Central School, Punakha
3	Cheki Wangmo	The Use of Numbered Heads Together (NHT) on the Learning Achievement of Bhutanese 6th Grade Students in Science	Tongmijangsa Primary School, Trashiyangtshe
4	Damber Singh Mongar	The Use of Animated Movies to Enhance Narrative Writing Skills of Grade 6 Bhutanese ESL Students	Gaselo Central School, Wangduephodrang
5	Lhadon	The Use of Visual Imaginary Strategy to Enhance English Reading Comprehension Skills of Grade Four Bhutanese Students	Trashiyangtshe Lower Secondary School, Trashiyangtshe
6	Namkha Wangdi	Motivation Among ESL learners: An Investigative Study of Grade 12 Students in Bhutan	Karmaling Higher Secondary School and Orong Central School, Samdrupjongkhar
7	Norbu Kezang	The Application of Place-based Inquiry Approach on Grade 6 Bhutanese Students in Learning Environmental Science	Udzorong Central School, Tashigang
8	Pema Wangzom	The Use of Graphic Organizers in Teaching History to Grade Seven Students in Bhutan	Dekiling Middle Secondary School, Sarpang
9	Tenzin Jamtsho	The Effect of Using Games Incorporating Manipulatives in Geometry for Grade 6 Students in Trashiyangtshe, Bhutan	Trashiyangtshe Lower Secondary School, Trasgiyangtshe
10	Tshering Denkar	Teachers' Perception of Early Childhood Care and Development Centers: Effects on Pre-Primary Students in Bhutan	Paro district

Thank you for your kind consideration.

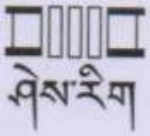
Truly yours,

Anchalee Chayanuvat

Assistant Professor Anchalee Chayanuvat, Ed.D.
Dean of Suryadhep Teachers College
Rangsit University
Muang-Ake. Paholyothin Road
Lakhok, Pathumtani 12000 THAILAND
Tel +662-997-2222 ext. 1275, 1276 Fax +662-997-2222 ext. 1277

 དཔལ་ལྡན་འབྲུག་གཞུང་། ཤེས་རིག་སྡེབ་ཁག།

Ministry of Education
Department of School Education
School Planning and Coordination Division



ཤེས་རིག

DSE/SPCD/SLCU(2.1)/2019/ 1645

August 2, 2019

The Principal
All the Participating School(s)

Subject: Approval to conduct research and collect data for M.Ed. Theses

Dear Sir/Madam,

The following group of teachers are currently undergoing M.Ed Program in Curriculum and Instruction at Suryadhep Teachers College in Rangsit University, Thailand. As part of the study program, they will be collecting data from the students and teachers for their research project from August 5 through September 30, 2019.

SL.NO	NAME	RESEARCH TITLE	RESEARCH SCHOOL
1	Chhimi Dorji	The Use of Project-Based Learning on Understanding Scientific Concepts of Grade 6 Bhutanese Students	Toncholing Primary School, Wangdue Phodrang
2	Buddha Singh Tamang	Application of Content and Language Integrated Learning (CLIL) Approach for English Learning of Secondary School Bhutanese Students	Punakha Central School, Punakha
3	Cheki Wangmo	The Use of Numbered Heads Together (NHT) on the Learning Achievement of Bhutanese 6th Grade Students in Science	Tongnijangsa Primary School, Trashiyangtse
4	Damber Singh Mongar	The Use of Animated Movies to Enhance Narrative Writing Skills of Grade 6 Bhutanese ESL Students.	Gaselo Central School, Wangdue Phodrang
5	Lhadon	The Use of Visual Imaginary Strategy to Enhance English Reading Comprehension Skills of Grade Four Bhutanese Students	Trashiyangtse Lower Secondary School, Trashiyangtse
6	Namkha Wangdi	Motivation Among ESL Learners: An Investigation Study of Grade 12 Students in Bhutan.	Karmaling Higher Secondary School and Orong Central School, Samdrupjongkhar
7	Norbu Kezang	The Application of Place-based Inquiry Approach on Grade 6 Bhutanese Students in Learning Environmental Science.	Udzorong Central School, Tashigang
8	Pema Wangzom	The Use of Graphic Organizers in Teaching History to Grade 7 Students in Bhutan	Dekiling Middle Secondary School, Sarpang.
9	Tenzin Jamtsho	The Effect of Using Games Incorporating Manipulatives in Geometry for Grade 6 Students in Trashiyangtse, Bhutan	Trashiyangtse Lower Secondary School, Trashiyangste
10	Tshering Dorkar	Teachers' Perception of Early Childhood Care and Development Centers: Effects on Pre-Primary students in Bhutan	Paro Dzongkhag Schools

In this regard, you are kindly requested to facilitate them to collect data as per their schedule with minimal disruption to instructional time of the school.

Thanking you

Sincerely yours,

(Kinley Gyeltshen)
Chief Program Officer

Copy to:
1. Chief DEO, Dzongkhag Administration, for kind information.

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

བཀྲིས་གཡང་རྩེ་འབྲིང་རིམ་སློབ་གྲྭ་འོག་མ།
TRASHIYANGTSE LOWER SECONDARY SCHOOL
TRASHIYANGTSE DZONGKHAG

Educating for GNH

Sherig/TYLSS/(41)/2019/A661

Date: 30 August, 2019

The Dean
Faculty of Education
Rangsit University
Thailand.

Subject: **Completion of Data Collection for M.Ed. Thesis**

Dear Madam,

Mr. Tenzin Jamtsho who is currently undergoing M.Ed Program in Curriculum and Instruction at Suryadhep Teachers College in Rangsit University, Thailand has completed data collection for his research project at Trashiyangtse Lower Secondary School from 5th – 30th August, 2019.

(Tashi Phuntsho)
Principal
Trashi Yangtse Lower Secondary School
Trashi Yangtse Dzongkhag

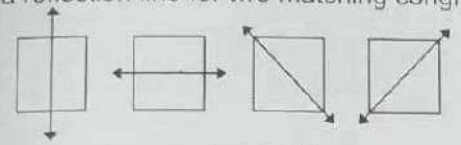
Trashi Yangtse Lower Secondary School * Dzongkhag
Date.....

APPENDIX B

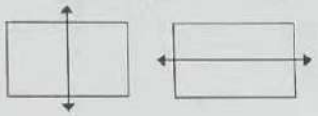
CONTENTS OF MATHEMATICS

2.3.1 EXPLORE: Planes of Symmetry

Some 2-D shapes have **mirror symmetry**. A **line of symmetry** acts like a reflection line for two matching congruent halves of the shape.

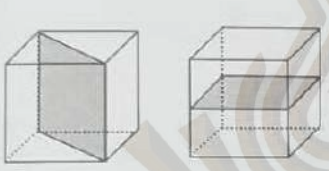


A square has four lines of symmetry.

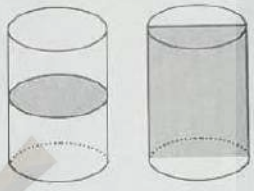


A rectangle has two lines of symmetry.

Some 3-D shapes have mirror symmetry. The imaginary surface that cuts a 3-D shape into congruent matching halves is called a **plane of symmetry**.



Some planes of symmetry of a cube.



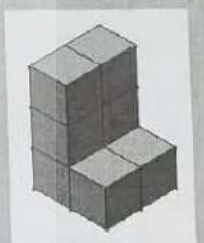
Some planes of symmetry of a cylinder.

A. Build these structures with cubes. Split each structure along a plane of symmetry in as many different ways as you can.

i)

ii)

iii)



B. Sketch or describe the planes of symmetry of each 3-D shape.

i)

Square-based pyramid

ii)

Equilateral triangle-based prism

iii)

Cone

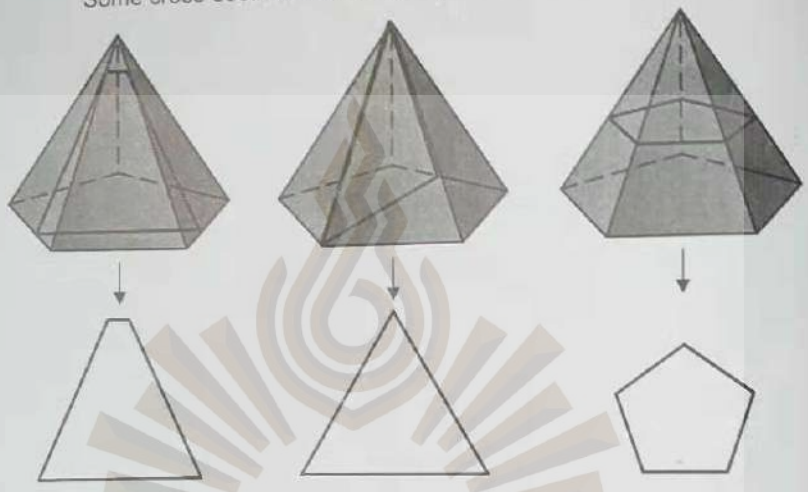
C. i) Describe the number of lines of symmetry of a circle.

ii) Describe the number of planes of symmetry of a cone or cylinder.

2.3.2 EXPLORE: Cross-sections

- When you make a straight cut through a 3-D shape, the 2-D shape of the cut surface that is exposed is called a **cross-section**.
- A cross-section can be made at any angle. In the examples below, each cross-section is parallel or perpendicular to the base.

Some cross-sections of a regular pentagon-based pyramid



Trapezoid cross-section | Triangle cross-section | Pentagon cross-section

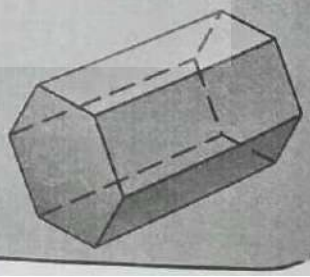
A. Make each shape below out of clay.

- cylinder
- cone
- square-based pyramid
- rectangle-based prism
- triangle-based prism

Use string or thin wire to make a straight cut that is parallel or perpendicular to any face. Sketch the cross-section.

Rebuild the 3-D shape and repeat until you have several cross-sections of different shapes and sizes.

B. Predict what the cross-sections of a hexagon-based prism will look like if they are made perpendicular or parallel to the base.

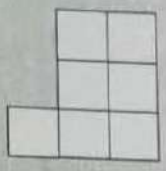


2.3.3 Interpreting Orthographic Drawings

Try This

Dorji looked at a cube structure straight on from different views. He made these drawings of what he saw.

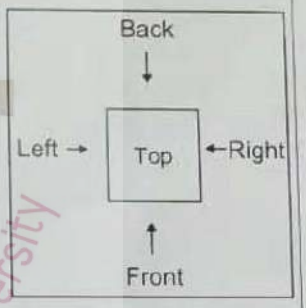
View from the back



View from the right

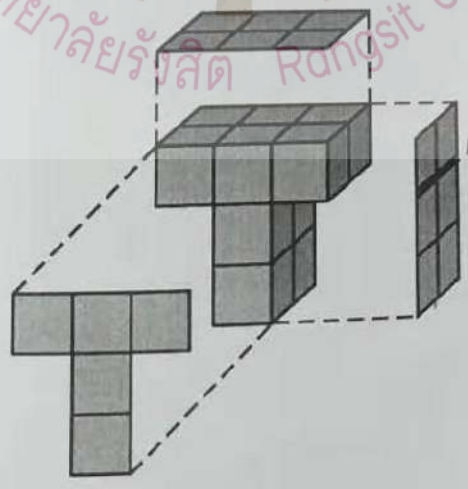
A. Use linking cubes to build a structure that matches Dorji's drawings.

- **Orthographic drawings** are a set of 2-D drawings of a 3-D structure. Each drawing is called a **face view**. Each face view is made by looking at the structure straight on from a different direction.
- A set of orthographic drawings can help you see features of the structure that might be hidden in any single view.
- The views that might be included in a set of orthographic drawings are top, front, back, left, and right.

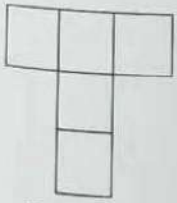


- A heavier line is used to show a change in depth.

Top view



Right view



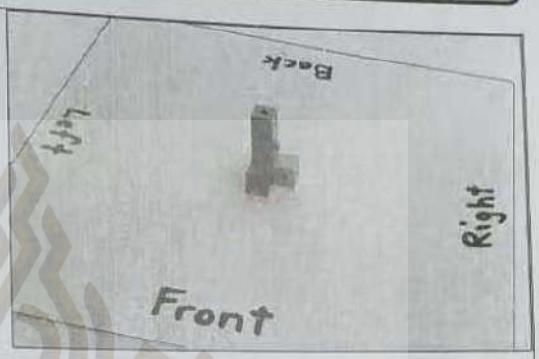
Front view

2.3.4 Creating Orthographic Drawings

Try This

A. i) Build a cube structure using 7 or more cubes.
ii) Draw the top, left, right, back, and front face views of your structure.

- When you create orthographic drawings, it is helpful to begin by placing the structure on a paper marked front, right, left, and back.
- You can also use grid paper if the structure is built from cubes.



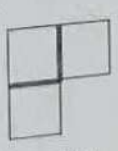
- For each view (front, right, left, and back), turn the paper to see each face straight on.
- Draw what you see.

Front view

- Look at the structure from a slightly different angle to see if there are changes in depth. Mark the changes in depth with a heavier line.

Front view

- To draw the top view, look straight down at the structure from above with the front of the structure closest to you.



Top view

APPENDIX C

LEARNING ACHIEVEMENT TEST QUESTIONS

Questions for Learning Achievement Test

Objectives:

Each student should be able to:

- Identify symmetrical shapes correctly.
- Explain cross-sections of different 3 D shapes correctly.
- Create cube structures correctly using orthographic drawings.

Section A: Multiple Choice Questions (10 marks)

Choose the most correct answer from the options provided.

1. In the figure below, which of the following is a line of symmetry? (1)

A. 

B. 

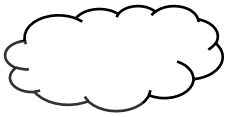
Answer: …….

2. Which item is not symmetrical? (2)

A. 

C. 

B. 

D. 

Answer: …….

3. How many cross sections does a regular pentagon- based pyramid have?

A. 3

C. 1

B. 2

D. 4

Answer: …….

4. What is the cross- section of football?

A. Square

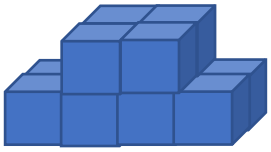
C. Triangle

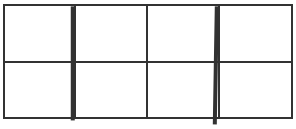
B. Circle

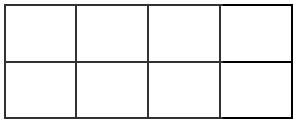
D. Pentagon

Answer: …….

5. Choose the most correct top view for the following figure?



A. 

C. 

B. 

D. 

Answer: ……

Section B: True or False

Write **(True)** if the statement is **correct** and **(False)** if the statement is **incorrect** in the **bracket** provided against the statement. (5 marks)

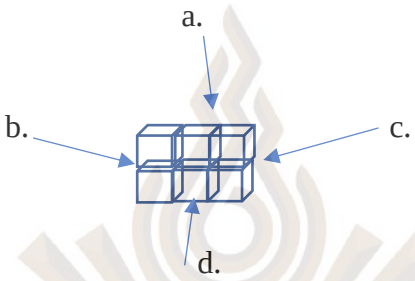
1. A plane of symmetry is a plane which divides an object into two equal parts. ( ).
2. A sphere will have only one cross sections. ( )
3. A sphere will have two planes of symmetry. ( )
4. A change of depth is shown with the thin line in orthographic drawing.( ).
5. Orthographic drawings are the 2-D drawings of a 3-D shapes. ( ).

Section 2: Short Answer Type

Answer all the questions

1. Label the following structure with principle views in orthographic views?

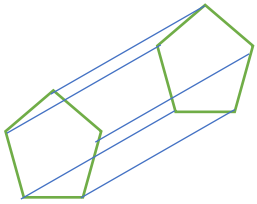
(2 marks)



2. Study the following figure and answer questions a and b.

   a. show the possible planes of symmetry for the figure with the help of drawing. (1.5marks)
   b. Show the possible cross sections of the figure with the help of drawing. (1.5marks)

3. Examine the pentagon- based prism:



a. Sketch the Planes of symmetry. (1 mark)

b. Sketch possible cross- sections. (1 mark)

4. Study the following orthographic drawing and create the most suitable cube structure. (3 marks)

Top view

Right view

Back view

APPENDIX D

IOC FOR LEARNING ACHIEVEMENT TEST

Item Objective Congruence for Test Questions by the Experts

Sl.No	Attributes	Expt 1	Expt 2	Expt 3	Average	Congruence
1	(Multiple Choice Question) Question 1	+1	+1	+1	+1	Congruent
2	(Multiple Choice Question) Question 2	+1	+1	+1	+1	Congruent
3	(Multiple Choice Question) Question 3	+1	+1	+1	+1	Congruent
4	(Multiple Choice Question) Question 4	+1	+1	+1	+1	Congruent
5	(Multiple Choice Question) Question 5	+1	+1	+1	+1	Congruent
6	(True or False) Question 1	+1	+1	+1	+1	Congruent
7	(True or False) Question 2	+1	+1	+1	+1	Congruent
8	(True or False) Question 3	+1	+1	+1	+1	Congruent
9	(True or False) Question 4	+1	+1	+1	+1	Congruent
10	(True or False) Question 5	+1	+1	+1	+1	Congruent

Item Objective Congruence for Test Questions by the Experts (Cont.)

Sl.No	Attributes	Expt 1	Expt 2	Expt 3	Average	Congruence
11	(Short answer type) question 1	+1	+1	+1	+1	Congruent
12	(Short answer type) question 2 a	+1	+1	+1	+1	Congruent
13	(Short answer type) question 2 b	+1	+1	+1	+1	Congruent
14	(Short answer type) question 3 a	+1	+1	+1	+1	Congruent
	Overall Average				+1	Congruent

APPENDIX E

STRUCTURED INTERVIEW QUESTIONS

Structured Interview Questions

The individual semi structured interview will be used to determine the student's perception toward the use of game incorporating manipulatives in geometry.

Sl. No	Semi-Structured Interview questions
1	How do you enjoy the Mathematics classes? Could you describe how you usually learn Mathematics?
2	Share your opinions about learning Geometry using games incorporating manipulatives.
3	How did your interest in mathematics change because of your participation in games incorporating manipulatives?
4	What did you enjoy most while participating in classroom activities?
5	How did the use of games incorporating manipulatives in learning geometry promote your interaction between your peers and teacher?
6	Did the use of games incorporating manipulatives improve your self-confidence in asking your doubts?
7	What were the most important skills or lesson learnt from the session?
8	Would you prefer to learn other topics through the games incorporating manipulatives?

Semi Structured Interview Adapted from: Tashi, 2019

APPENDIX F

IOC FOR STRUCTURED INTERVIEW QUESTIONS

Item Objective Congruence for Semi Structured Interview questions by the Experts

Sl. No	Semi-Structured Interview questions	Expert 1	Expert 2	Expert 3	Average	Congruence
1	Did you enjoy the Mathematics classes? Could you describe how you usually learn Mathematics?	+1	+1	+1	+1	Congruent
2	Share your opinions on learning Geometry using games incorporating manipulatives.	+1	+1	+1	+1	Congruent
3	How did your interest in mathematics change because of your participation in games incorporating manipulatives?	+1	+1	+1	+1	Congruent
4	What did you enjoy most while participating in classroom activities?	+1	+1	+1	+1	Congruent

Item Objective Congruence for Semi Structured Interview questions by the Experts (C0nt.)

Sl. No	Semi-Structured Interview questions	Expert 1	Expert 2	Expert 3	Average	Congruence
5	How did the use of games incorporating manipulatives in learning geometry promote your interaction between your peers and teacher?	+1	+1	+1	+1	Congruent
6	Did the use of games incorporating manipulatives improve your self-confidence in asking your doubts?	+1	+1	0	0.666667	Congruent
7	What were the most important skills or lesson learnt from the session?	+1	+1	+1	+1	Congruent
8	Would you prefer to learn other topics through the games incorporating manipulatives?	+1	+1	+1	+1	Congruent
	Overall Average				0.958333	Congruent

APPENDIX G

LESSON PLANS

Lesson Plans

Lesson Plan No: 1

Class: VI **Subject: Mathematics**

Topic: Planes of Symmetry **Time: 60 Mins**

Teaching Learning Materials: Chalk, Chalkboard, Snap cubes and sample net of cube, chart papers, markers, glue/masking tape/ cello tape

Lesson Objective(s):

By the end of the lesson, every child should be able to:

- ✓ Define the term plane of symmetry correctly.
- ✓ Explain that some 3-D shapes do not have planes of symmetry.
- ✓ Investigate and tell the planes of symmetry for cubes, cone, cylinder, prism, and pyramid.

Time	Lesson Component	Teacher Activity	Learner Activity
5 Mins	**Lesson Introduction**	Greet the class Display the charts containing the picture of 2 – D shapes. Then ask them • What do you see in the chart? • What are the names of these shapes? • Where can you find these shapes?	Greets back Expected responses: • 2-D shapes or shapes. • Circle, Square, Rectangle, Triangle, Pentagon • Green board, pencil, Chalk

Time	Lesson Component	Teacher Activity	Learner Activity
		• What would be the topic that we are going to discuss? Introduce the topic by writing 'Planes of Symmetry' on the board.	• geometry set box, window • 2-D shapes, Shapes, Write the topic in their notebook.
10 Mins	**Lesson Development**	Write the definition of 'Planes of Symmetry' on the board as: A plane of symmetry is a plane that cuts any solid into two equal halves. Eg: When we cut a ball into two equal parts a surface is formed called Planes of symmetry. 3-D shapes can be cut into two equal parts in many ways and Some 3-D shapes can have more than one plane of symmetry.	Observe and listen
25 mins	**Activity 2 (Major Activity)**	We are going to play a game called 'building the castle!' To play this game you will be divided into eight groups of four members.	

Time	Lesson Component	Teacher Activity	Learner Activity
		I will provide you with clay and a set of 3-D blocks in each group. You will use 3-D blocks to construct castle and use clay to make cube, cone, cylinder, prism, and pyramid. You will cut each shape made out of clay in different ways making sure that the shapes are congruent. List all possible plane of symmetry that your group has found from each shape. When you finish finding planes of symmetry for each shape, you will use 3-D block of the shape to build the castle and start cutting and finding planes of symmetry of other shapes listed on the Board. A group which completes building castle first will be the winner but if the planes of symmetry for a shape are missing in your list or error in the finding, then 1 point will be deducted for each missing or inappropriate planes of symmetry while presenting to the class.	Explore Planes of symmetry for cube, cone, cylinder, prism, and pyramid.

Time	Lesson Component	Teacher Activity	Learner Activity
	Monitoring	Teacher will move around and provide necessary support to the needy groups.	Raise hand and seek help.
15 mins	**Follow up**	Teacher will provide necessary feedbacks and suggestion if required. Award group points to nominate winner of the month.	A student will represent their group and present their findings of planes of symmetry to the whole class.
5 mins	**Lesson Closure**	Ask few questions to couple of students and assign them homework to explore more on find planes of symmetry in triangular prism, triangle-based pyramid, hexagonal pyramid.	Students will to answer the question and if there are no volunteer teacher will call the number.

APPENDIX H

IOC FOR LESSON PLANS

Item Objective Congruence for Lesson Plans by the Experts

Item No	Attributes	Expert 1	Expert 2	Expert 3	Average	Congruence
1	Lesson Plan 1	+1	+1	+1	+1	Congruent
2	Lesson Plan 2	+1	+1	+1	+1	Congruent
3	Lesson Plan 3	+1	+1	+1	+1	Congruent
4	Lesson Plan 4	+1	+1	+1	+1	Congruent
	Overall Average				+1	Congruent

APPENDIX I

STRUCTURED OBSERVATION

Structured Observation

Sl. No	Observation Statements	Yes	No
1	Learners actively involves in the lesson activities through fun.		
2	Learners actively volunteers to answer the question.		
3	Learners discusses the assigned task in a group and come up with the solutions.		
4	Learners uses their prior knowledge to answer the questions in lesson introductory part.		
5	Every learner is actively interactive in the group discussion.		
6	Learners are motivated to complete their work before or within time frame provided by the teachers.		
7	Learners were very mindful to listen and follow the instructions correctly.		
8	learners are comfortable to seek help from peers or teacher.		
9	Learners try to use the key words related to the topic like congruent, cross section, orthographic, symmetry, etc… while answering to the question.		
10	Every learner got an opportunity to participate in group works and present their group work to the class.		
Other comments			

Classroom Behavior Observation Adopted from: Kinley Dema, 2018

APPENDIX J

IOC FOR STRUCTURED OBSERVATION

Item Objective Congruence for Structured Observation by the Experts

Sl. No.	Behaviors observed	Expert 1	Expert 2	Expert 3	Average	Congruence
1	Learners actively involves in the lesson activities through fun.	+1	+1	+1	+1	Congruent
2	Learners actively volunteers to answer the question.	+1	+1	+1	+1	Congruent
3	Learners discusses the assigned task in a group and come up with the solutions.	+1	+1	+1	+1	Congruent
4	Learners uses their prior knowledge to answer the questions in lesson introductory part.	+1	+1	0	0.66666667	Congruent
5	Every learner is actively interactive in the group discussion.	+1	+1	+1	+1	Congruent
6	Learners completes their work before or within time frame provided by the teachers.	+1	+1	+1	+1	Congruent

Sl. No.	Behaviors observed	Expert 1	Expert 2	Expert 3	Average	Congruence
7	Learners are very mindful to listen and follow the instructions correctly.	+1	+1	+1	+1	Congruent
9	Learners uses key words related to the topic like congruent, cross section, orthographic, symmetry, etc… while answering to the question.	+1	+1	+1	+1	Congruent
10	Every learner gets an opportunity to participate in group works and present them group work to the class.	+1	+1	+1	+1	Congruent

APPENDIX K

EXPERTS WHO VALIDATED THE RESEARCH INSTRUMENTS

Names of the Expert who Validated the Instruments

Sl. No	Name	Position Title	Institute
1	Dr. Usaporn Swekwi	Associate Professor	Rangsit University
2	Dorji Wangchuk	Principal	Katsho Lower Secondary School
3	Tashi	Teacher	Wangdi Primary School

APPENDIX L

WILCOXON SIGNED RANK TEST

Wilcoxon Signed Ranked Test

Descriptives

			Statistic	Std. Error
Pretesttest_Score	Mean		6.3393	.30107
	95% Confidence Interval for Mean	Lower Bound	5.7215	
		Upper Bound	6.9570	
	5% Trimmed Mean		6.2937	
	Median		6.0000	
	Variance		2.538	
	Std. Deviation		1.59312	
	Minimum		4.00	
	Maximum		9.50	
	Range		5.50	
	Interquartile Range		2.38	
	Skewness		.516	.441
	Kurtosis		-.247	.858
Posttest_score	Mean		12.7857	.34830
	95% Confidence Interval for Mean	Lower Bound	12.0711	
		Upper Bound	13.5004	
	5% Trimmed Mean		12.8095	
	Median		12.5000	
	Variance		3.397	
	Std. Deviation		1.84305	
	Minimum		9.00	
	Maximum		16.00	
	Range		7.00	
	Interquartile Range		2.88	
	Skewness		.029	.441
	Kurtosis		-.756	.858

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Pretesttest_Score	28	6.3393	1.59312	4.00	9.50
Posttest_score	28	12.7857	1.84305	9.00	16.00

Ranks

		N	Mean Rank	Sum of Ranks
Posttest_score - Pretesttest_Score	Negative Ranks	0[a]	.00	.00
	Positive Ranks	28[b]	14.50	406.00
	Ties	0[c]		
	Total	28		

a. Posttest_score < Pretesttest_Score
b. Posttest_score > Pretesttest_Score
c. Posttest_score = Pretesttest_Score

Test Statistics[a]

	Posttest_score - Pretesttest_Score
Z	-4.628[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

APPENDIX M

EXTRACTS OF STRUCTURED INTERVIEW

Participants Responses to the Structured Interview

Student No.	Q.1 How did you enjoy the Mathematics classes? Could you describe how you usually learn Mathematics?
1	We played games using manipulatives during the mathematics classes and it was really interesting.
2	I have enjoyed the mathematics classes as there was group discussion and games being played. In other normal classes teachers keeps on teaching and we keep on listening to the teacher.
3	I have enjoyed the mathematics classes as there were games during the activity and in the normal class teacher does not let us play games.
4	Yes, we enjoyed mathematics class as we had a discussions and games played in our teams and it was interesting. In normal class, teacher usually explains a lot and it let us get confuse sometimes.
5	Yes, we enjoyed the mathematics class because there were games and competition among the groups. Usually there use to be very little discussion and most of the time we have to solve question by self.
6	I have enjoyed the mathematics class as there were games being played among the groups. Usually in our normal class, we don't play games.
7	I enjoyed the mathematics class because we discussed the questions and had a competition among groups in a form of games. In others class, teacher does not let us play games during the lessons.
8	Yes, I have enjoyed the mathematics class as it forced us to be corporative in the group for the group competition. In other normal class we just try to solve question on our own.
9	Yes, the mathematics class was fun as teacher taught the lesson through games and in our normal class, our teacher doesn't teach us using games.
10	I enjoyed the class because we have learned lesson by playing games. In normal classes we do not play games.

APPENDIX N

STRUCTURED OBSERVATION

It is the qualitative data collection method which observes learners' behavior to examine the perception of learners towards of the use of games incorporating manipulatives in geometry. The observation will be carried out by the researcher and two other experienced peer teachers. The classroom observation will be carried out in all four treatment lessons of the researcher.

Sl. No	Observation Statements	Yes	No
1	Learners are actively involved in the lesson activities through fun.	✓	
2	Learners volunteers to answer the question.	✓	
3	Learners discusses the assigned task in a group and come up with the solutions.	✓	
4	Learners use their prior knowledge to solve the task.	✓	
5	Learners are able to explore more with the help of games incorporating manipulatives.	✓	
6	The learners are motivated to take up new challenges related to the topic.	✓	
7	Learners were very mindful to listen and follow the instructions correctly.	✓	
8	learners were comfortable to seek help from peers or teacher.	✓	
9	Learners always try to give answers with logical reasoning.	✓	
10	Motivate every learner to present their group work to the class.	✓	
Other comments	The learners were motivated and they participated actively in the process of learning.		

It is the qualitative data collection method which observes learners' behavior to examine the perception of learners towards of the use of games incorporating manipulatives in geometry. The observation will be carried out by the researcher and two other experienced peer teachers. The classroom observation will be carried out in all four treatment lessons of the researcher.

Sl. No	Observation Statements	Yes	No
1	Learners are actively involved in the lesson activities through fun.	✓	
2	Learners volunteers to answer the question.	✓	
3	Learners discusses the assigned task in a group and come up with the solutions.	✓	
4	Learners use their prior knowledge to solve the task.	✓	
5	Learners are able to explore more with the help of games incorporating manipulatives.	✓	
6	The learners are motivated to take up new challenges related to the topic.	✓	
7	Learners were very mindful to listen and follow the instructions correctly.	✓	
8	learners were comfortable to seek help from peers or teacher.	✓	
9	Learners always try to give answers with logical reasoning.	✓	
10	Motivate every learner to present their group work to the class.	✓	
Other comments	The learners were engaged and participated thoroughly with lots of interest in the topic that they were taught.		

It is the qualitative data collection method which observes learners' behavior to examine the perception of learners towards of the use of games incorporating manipulatives in geometry. The observation will be carried out by the researcher and two other experienced peer teachers. The classroom observation will be carried out in all four treatment lessons of the researcher.

Sl. No	Observation Statements	Yes	No
1	Learners are actively involved in the lesson activities through fun.	✓	
2	Learners volunteers to answer the question.	✓	
3	Learners discusses the assigned task in a group and come up with the solutions.	✓	
4	Learners use their prior knowledge to solve the task.	✓	
5	Learners are able to explore more with the help of games incorporating manipulatives.	✓	
6	The learners are motivated to take up new challenges related to the topic.		✓
7	Learners were very mindful to listen and follow the instructions correctly.	✓	
8	learners were comfortable to seek help from peers or teacher.	✓	
9	Learners always try to give answers with logical reasoning.	✓	
10	Motivate every learner to present their group work to the class.		✓
Other comments			

APPENDIX O

RELIABILITY COEFFICIENT

Reliability of Achievement Test Questions

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

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

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.709	.716	14

APPENDIX P

CONSENT LETTER

Consent Letter

Dear Parents,

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 "Use of Games Incorporating Manipulatives in Teaching Geometry to grade Six Bhutanese Students". This research requires student participation. The instruments involved during the study are pretest and posttest, semi structured interview and classroom behavior observation 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 for your cooperation in approving your children to participate in this research study.

Yours sincerely
Tenzin Jamtsho
Student
Rangsit University
Thailand.

I acknowledge that the content of this research study has been thoroughly explained to me and any questions have been answered. I lave read the letter provided by Mr. Tenzin Jamtsho and have agreed to let my child (……) participate in the research as decrribed.

Name: …… Signature: ……..
Date: ……

BIOGRAPHY

Name	Tenzin Jamtsho
Date of Birth	September 28, 1987
Place of Birth	Thimphu, Bhutan
Institution Attended	Paro College of Education, Bhutan Bachelor Degree of Education, 2014 Rangsit University, Thailand Masters of Education in Curriculum and Instruction, 2019
Scholarship	Thailand International Cooperation Agency Scholarship (TICA)
Address	Tshaling, Trashiyangtse, Bhutan
Email Address	zhockpojamtsho@gmail.com