

## การใช้เกมร่วมกับสื่อ MANIPULATIVES ในการสอนวิชาเรขาคณิตสำหรับนักเรียนชั้นมัธยมศึกษาปีที่ 6 ประเทศภูฐาน

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### บทคัดย่อ

งานวิจัยนี้เป็นงานวิจัยแบบผสมผสาน มีวัตถุประสงค์เพื่อ 1) ศึกษาผลของการใช้เกมร่วมกับสื่อ MANIPULATIVES ที่มีต่อผลสัมฤทธิ์ในการเรียนวิชาเรขาคณิตสำหรับนักเรียนชั้นมัธยมศึกษาปีที่ 6 ประเทศภูฐาน และ 2) ศึกษาแแนวความคิดของนักเรียนชั้นมัธยมศึกษาปีที่ 6 ประเทศภูฐาน ต่อการใช้เกมร่วมกับสื่อ MANIPULATIVES ในการเรียนวิชาเรขาคณิต เครื่องมือวิจัยประกอบด้วย แบบทดสอบก่อนหน้าและหลังการทดลองสอน (ข้อมูลเชิงปริมาณ) การสัมภาษณ์แบบกึ่งโครงสร้าง และการสังเกตในชั้นเรียน (ข้อมูลเชิงคุณภาพ) วิเคราะห์ข้อมูลโดยใช้ค่าเฉลี่ย ค่าเบี่ยงเบนมาตรฐาน การทดสอบลำดับที่โดยเครื่องหมายของวิลค์อกซัน และ การวิเคราะห์แก่นสาระ คัดเลือกกลุ่มตัวอย่างด้วยวิธีการสุ่มตัวอย่างแบบกลุ่มจากนักเรียนชั้นประถมศึกษาปีที่ 6 จำนวนสองห้องห้องละ 28 คน กลุ่มตัวอย่างได้รับการสอนโดยใช้เกมร่วมกับสื่อ MANIPULATIVES เป็นเวลา 1 เดือน ผลการทดสอบก่อนหน้าและหลังจากการใช้สื่อพบว่า�นักเรียนมีผลสัมฤทธิ์ในการเรียนวิชาเรขาคณิตดีขึ้น อย่างมีนัยสำคัญ โดยมีค่าเฉลี่ยก่อนเรียน 6.33 และค่าเฉลี่ยหลังเรียน 12.78 (ความแตกต่างของ ค่าเฉลี่ย = 6.45) ผลการสัมภาษณ์และการสังเกตในชั้นเรียนแสดงว่า�นักเรียนมีแนวความคิดในเชิงบวกต่อการใช้ เกมร่วมกับสื่อ MANIPULATIVES ในการเรียนวิชาเรขาคณิต นักเรียนสนุก มีแรงจูงใจในสภาพแวดล้อมที่เอื้อต่อ การเรียนรู้จากการใช้เกมร่วมกับสื่อ MANIPULATIVES ผลการวิจัยข้างต้นสามารถใช้เพื่อสนับสนุนการใช้เกม ร่วมกับสื่อ MANIPULATIVES ในการเรียนวิชาเรขาคณิตสำหรับนักเรียนชั้นมัธยมศึกษาปีที่ 6 ประเทศภูฐาน

**คำสำคัญ :** เกม สื่อ Manipulatives วิชาเรขาคณิต

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

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### 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 method), semi structured interview and classroom behavior observation (qualitative method) and analyzed using mean, standard deviation, Wilcoxon signed rank test and thematic analysis. A section was selected out of two sections (consisted of 28 learners in each section) of grade six as a research participant through the use of a clustered random sampling method. The sample group was taught using games incorporating manipulatives for a period of one month. The result of pretest and posttest displayed that the use of games incorporating manipulatives enhanced the learning achievement of grade six Bhutanese learners in geometry. The mean score 6.33 in pretest and the mean score 12.78 in posttest made the mean difference of 6.45 which showed significant improvement. The data analyzed from semi structured interview and classroom behavior observation confirmed that the learners had positive perception towards the use of games incorporating manipulatives in learning geometry. The learners enjoyed and were motivated in conducive learning environment created by the use of games incorporating manipulatives. Therefore, the analysis of all research data supported the implementation of games incorporating manipulatives in learning geometry for grade six Bhutanese learners.

**Keywords :** Games, Manipulatives, Geometry

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## Introduction

The seed of modern education system was sown since from 1914 when the First king of Bhutan Gonsar Ugyen Wangchuck sent forty-six Bhutanese boys to India to pursue western education (Tobgay, 2014, p. 2). In the same year the school was established in Haa district and later in Bumthang district in the year 1915 (Jagar, 2005, p. 10). According to Takehiro (2015) those schools were for educating crown prince and children of royal attendants. The significant role 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 H. , 2015). Since then the age-old policy of isolation was pierced with the dawn of modern education.

Dukpa (2015) stated that "Mathematics has 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 was found teacher centered limiting students from active involvement in learning process. Therefore, since mid-1980s, there was a gradual transformation of mathematics curriculum aligning with constructivist theories and in year 2008, the curriculum was transformed and implemented in the schools of Bhutan (Lham, 2017).

A study conducted by Royal Education Council revealed that "many students are performing below expectations of their grade level on both basic and advanced academic skill, lack basic communication and analytical skills..." The same concern was reiterated by the Minister of Education during the 17th Session of the National Council (June 22, 2016) that on average a student requires one additional year to achieve the same level of competency for that grade (Education, 2016). Based on the findings, the level of educational performance of most Bhutanese students were below expectation. It meant the performance level in mathematics curriculum is also low.

As per 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 means 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. Further, as per the performance assessment of three domains in PISA - D (Programme 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. 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 was not with the curriculum framework but with the way it was implemented in the classroom. Hence, it is liable to state that, the age – old teacher centered teaching method still prevailed in the education system. In the study of Jameel & Ali (2016) revealed that teachers being very strict in the process of teaching mathematics, limited activities and lack of attention were the main causes of low achievement in the mathematics as mentioned by students, teachers and parents respectively. Rigid culture and education systems contribute in developing mathematics anxiety (Hamza & Helal, 2013).

In the world of education, the educational hurdles are overcome by numerous inventions of strategies. One of the strategies gaining momentum in this century is the use of games. Game is an approach through which learners are driven through competition, engagement and immediate reward which fosters motivation and achievements (Teed, n.d). Game includes the use of computer and video games aiming to achieve the learning outcomes (Rivera, 2016). However, the fact is most of the schools in Bhutan are not well equipped with the advance technological facilities due to economic status and harsh geographical condition (Dawa, 2018). Therefore, implementing gamification is not suitable in context of Bhutanese school but the implementation of games incorporating manipulatives was an 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 is affordable as compared to digital gadgets. Moreover, manipulatives are being supplied in the schools by the government. Therefore, it will be applicable. Kontaş (2016) reveals that the long-term use of concrete manipulatives improves learner's perception toward mathematics along with the performance. Gundogdu (2013) also points out that, the use of manipulatives in the classroom has geared up performance of learners and developed positive perception towards mathematics subject. Sidiqi (2017) states that the mathematics anxiety can be reduced by using manipulatives in the process of teaching and learning.

#### **Research Objectives:**

1. To examine the effect of using games incorporating manipulatives on learning achievement in geometry of grade six Bhutanese students.
2. To find out perception of grade six Bhutanese students towards the use of games incorporating manipulatives in learning geometry.

### Research Questions:

1. Did the use of games incorporating manipulatives have an effect on the learning achievement of grade six Bhutanese students in geometry?
2. What was the perception of grade six Bhutanese learners towards the use of games incorporating manipulatives in learning geometry?

### Research Methodology

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 in teaching geometry. The pretest and posttest were used to collect quantitative data to determine learning achievement while semi structured interview and classroom behaviors observation were used to collect qualitative data to identify students' perception towards the use of games incorporating manipulatives.

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 clustered random sampling to select a section as a sample group that consisted of 28 with the mixed ability and gender. Their age ranged from 12 to 14 years. To avoid bias in recruiting the sample group, the researcher requested the principal of the school to randomly pick a paper which had the names of the sections of grade six.

The validity of the test questions was approved after thorough review of the content coverage, relevancy, language accuracy and appropriateness, feedbacks and recommendations by three experts' Item- Object Congruence (IOC). All the items had an IOC of 1.00 which confirmed that the items used in the questions were valid. To determine the reliability of test questions for pretest and posttest, reliability test was conducted to 36 grade six learners from different school in Trashiyangtse district, Bhutan. Kuder- Richardson coefficient (KR-20) was applied to calculate the reliability test and the value obtained was 0.71 which indicated reliable. The validity for both semi structured interview and classroom observation were validated by three experts' Item- Object Congruence (IOC). The items with validity score of 0.5 – 1.00 were used for semi structured interview and classroom behaviors observation.

The letter of approval for data collection from Rangsit University was forwarded to Ministry of Education of Bhutan seeking the consent. The Ministry directed the research school to support the researcher on data collection process. The consent was also sought from research participant's parents as the participant were aged below 18 years.

## Research Results

The data collected from pretest and posttest, semi structured interview and classroom behavior observation were analyzed and interpreted in the following classifications:

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

To answer this question, the data collected from the pretest and posttest scores of the sample groups were used by executing pretest and a posttest. A comparative statistical analysis was computed ‘within the group’ using Wilcoxon signed rank test because the number of research participants in the study were fewer than 30. The comparison was done in terms of mean, standard deviation, significance value of pretest and posttest scores of the sample group as shown in Table 1

**Table 1** 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 1 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. The standard deviation of pretest and posttest were 1.59 and 1.84 respectively.

**Table 2** Wilcoxon signed rank test

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

- a. Posttest score < Pretest score
- b. Posttest score > Pretest score
- c. Posttest score = Pretest score

Table 2 illustrated, there were 28 research participants who performed the achievement test. In contrast with the pretest, every learners' score was improved in the posttest. Thus, it was concluded that none of the learners were in negative rank category (0 negative rank) and on the other hand, all learners secured positive rank category (28 positive rank). 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.

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

The data were collected through semi structured interview and learning behavior observation in order to answer the question:

#### Classroom Behavior Observation

The researcher conducted four classes and all four classes were observed by a peer teacher to address second research question. Classroom Observations were analyzed based on four core themes: 1) Enjoyment, 2) Self Confidence, 3) Learning through Collaboration and 4) Motivation for Learning. The data supported the predominance of these four themes while learning geometry using games incorporating manipulatives.

#### Semi Structured Interview

One of the instruments used by the researcher to examine the fulfillment of learning perception was semi structured interview. The researcher transcribed the data, analyzed through the process of coding and thematic analysis to unveil the learners' perception towards the use of games incorporating manipulatives. The responses from the learners corresponded to the classroom behavior observation revealing the four mentioned themes.

The data analyzed from classroom behavior observation and semi structured interview resolved that the learners had positive perception towards the use of games incorporating manipulatives in learning geometry. The learners were enjoyed and motivated in conducive learning environment created by the use of games incorporating manipulatives.

### Discussion

The study disclosed two major findings. The first finding of this study was the use of games incorporating manipulatives 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.

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 was in line with the study carried out by Bahrami, Chegini, & kianzadeh (2012); Akinsola & 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 were offered with the platform to learn by doing which makes teaching and learning mathematics practical, expressive and retainable. The finding was also supported by the studies carried out by (Makri & Vlachopoulos 2017). They 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 teaching method enjoyed by learners and at the same time it encourages learners to participate actively and collaboratively. In this learning environment learners are provided with the opportunities to develop critical thinking, take accountability for decision making, problem solving.

The possible reasons for improvement in the learning achievement could be due to the active engagement of the learners in the learning process. In this study, learners were actively engaged to think, discuss and solve the problems given by the researcher which 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.

In this study learners were fully engaged during the learning session. Learners were given freedom to discuss, share and even enjoyed greater freedom to ask and seek help from teacher as well as from peers which created stress free classroom. Another reason for the positive learning achievement was the social interactions because the learners were given equal opportunity to interact, share and guide each other's learning which created interactive and conducive learning environment in the classroom.

The second major finding of the study was that learners had positive perception towards the use of games incorporating manipulatives in geometry. The data collected through semi structured interview revealed that learners were highly positive towards the use of games incorporating manipulatives. Almost all the learners enjoyed learning with the use of games

incorporating manipulatives throughout the learning session. Learners learnt with fun and curiosity which made the class interactive, engaging and productive.

This result was parallel to the findings of Ku, Chen, Wu, Lao, & Chan (2014) who claimed that, the infusion of games not only had positive impact in harvesting colorful results but also improved the confidence of the learners in mathematics. Similarly, the studies carried out by Bahrami, Chegini, & kianzadeh (2012) stated that, the group of learners in Instructional game achieved significantly high score than the group of learners in traditional teaching method.

Kontas (2016) discovered that mathematics manipulative had a crucial role in imparting mathematics concepts and skills to the learners which contributed to significant improvement in the learning achievement. The claim was supported by the high scores achieved in the posttest as compared to the pretest. It was also confirmed that, the Mathematics manipulatives had greatly impacted in learner's perspective towards Mathematics subject. Similarly, Larbi & Mavis (2016) stated that manipulatives provided a meaningful learning experiences helping learners to construct their own mathematical ideas and promoted Inquiry-based learning skills. Hence, the use of manipulatives in teaching-learning process of mathematics enhanced retention capability and learning motivation ultimately improving the test achievements.

## Conclusion

In conclusion, the use of games incorporating manipulatives fostered active learning engagement as the learners were delegated for certain responsibilities which individual were accountable during the entire activity. It helped learners to comprehend abstract concepts in a simplified manner since they used manipulatives to explore and go through rigorous discussion to solve the given problem. Thus, the learners learnt with hand on practice through which they experimented their learning in trial and error method. The skills and concepts learnt were retained for longer period of time. Therefore, the use of games incorporating manipulatives was one of the effective approaches to improve learning achievement.

## Recommendations

### Recommendation for Practice

1. Curriculum developers are recommended to explore and incorporate more games and manipulatives resources in the curriculum.
2. Teachers must be provided professional development programs in teaching mathematics using games and manipulatives.
3. Teachers are recommended to use games incorporating manipulatives to make lessons more interesting and engaging to enhance learning achievement.

4. The use of games incorporating manipulatives in daily classroom teaching is highly recommended since Learners showed positive perception towards it.

### **Recommendation for future research studies**

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

1. This study used only few games incorporating manipulatives in few topics. Therefore, further research may be done with more games incorporating manipulatives in more topics.

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

3. 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.

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