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USE OF INSTRUCTIONAL GAMES TO ENHANCE ATTITUDE AND PERFORMANCE IN MATHEMATICS

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ABSTRACT

This study investigated the effect of using instructional games for reviewing concepts in mathematics lessons. Using a one-group pretest-posttest design, the researcher determines the effect of the board game on the attitude towards mathematics and performance in mathematics. Results show that the use of instructional games enhanced the performance in mathematics of the students. However, the use of instructional games did not improve students' attitude towards mathematics. Results also show that there is a positive relationship between attitude and performance in mathematics.

KEYWORDS: Performance, Attitude, Mathematics & Instructional Games

INTRODUCTION

Doing mathematics and thinking about how you are doing it at the same time, is not the easiest things to do. It is even more difficult if students are not aware that they should be attempting both processes at the same time. They are likely to concentrate on the immediate task of "doing" the mathematics, rather than trying to access the deeper process. Yet, it is this deeper process that is really at the heart of mathematics. In turn, accessing this deeper process requires in part some command of the appropriate rational/logical language so communication with yourself and others can proceed effectively and efficiently (Clarkson, 2008).

Mathematics is a subject offered from Kinder to College, and even in post-graduate studies. After graduating from college, a graduate student could have been fully equipped with mathematical skills, mastering the foundations and necessary concepts of mathematics.

As we step to the threshold of a modern society, knowledge of mathematics has become even more indispensable. Yet it is disheartening to note that most students experience not only an aversion, but phobia regarding the subject as well. Most of the students consider mathematics extremely difficult (Lee-Chua, 1999; as cited in Padilla, 2008).

Neil reported in his paper that attitude plays an important role in learning mathematics. This was confirmed and verified by Tinio who also cited that attitude affects achievement significantly (Bonto, 1991).

In 1995, a study was conducted and placed the Philippines at 39th rank in mathematics when its scores were compared with those 42 other countries. In 1999, among 38 countries, the Philippines ranked 36th in both science and mathematics tests, in the TIMSS-Repeat (1999 TIMSS Reports; Lee-Chua, 1999; Lee-Chua, 2001; 2001 IEA Reports; Cristobal 2000; Cristobal 2003; and Padilla, 2008). TIMSS 2003 placed the country at 23rd among 25 countries for both Grade 4 science and mathematics, and 42nd in science and 41st in mathematics among 45 countries for Second Year High

School (Cristobal, 2004; and Padilla, 2008).

These TIMSS reports only show that countries like Philippines needs help in enhancing mathematics education of the country. Results of the TIMSS are important in benchmarking student performance and institutional capability of schools, in formulating policies and interventions for improving science education and in providing indications on how the interventions affect the performance of students in science and math. More importantly, results of TIMSS gave useful inputs for policymakers in the development of programs for science and mathematics education (Cristobal, 2004; and Padilla, 2008).

In the Philippines, a yearly evaluation of students' performances in different learning areas is conducted. This is the National Achievement Test or NAT. In the descriptive statistical data released by the National Education Testing and Research Center (NETRC), it shows a consistent result of poor performance in the subject mathematics. The results in the National Mean Percentage Score for five school years (SY 2005-2006 to SY 2010-2011) for High School students NAT for the subject mathematics are 42.34; 39.06; 42.85; 38.03; 39.64; and 42.00.

The poor performance of students in Mathematics has become a source of worry to many individuals. The solution to this problem has been raised by many experts in the field, yet the problem tends to persist (Mefor, 2011). There are many factors affecting the poor performance in Mathematics, some of those are the so-called Mathematics anxiety by Fleming (2008) and boredom. Bonto (1991) revealed in his study that both grades V and VI pupils choose Mathematics as most difficult and hated subject, followed by Science, English and Music. Filipino is their easiest subject. According to Lariego (1990) students' attitudes toward mathematics are significantly related to the performance in mathematics.

In 2005, Gallup conducted a poll that asked students to name the school subject that they considered to be the most difficult. Not surprisingly, mathematics came out on top of the difficulty chart (Fleming, 2008).

To improve this poor performance of students in Mathematics, there's a need to enhance instruction in pursuit of knowledge in Mathematics.

Making Mathematics enjoyable and fun while learning the mathematical concepts is an important thing a Mathematics teacher must put into consideration first. One of the many ways to achieve this goal is to incorporate games in lessons. According to Stathakis (2013) games provide students a context for engaging practice. Moreover, games grab students' attention and actively engage them. For this reason, the researcher adapted instructional games that can be used in the fixing skills part of the lesson proper which will be used to aid the classroom instruction. The researcher will test its effectiveness in enhancing the performance in mathematics and attitude towards mathematics of the high school students.

LITERATURE REVIEW

Performance in Mathematics

Bonto (1991) found out that the major causes of poor mathematics skills were poor study habits, limited time for drill work, lack of mastery of the English language to comprehend problems, lack of mastery of the mathematical operations and poor understanding of mathematical terms and symbols. She also mentioned some causes of difficulties in mathematics like inadequate use of instructional materials and devices by teachers, inadequate explanations on operations used, lack of interest in mathematics and lack of remedial program for slow learners.

In the study conducted by Schenke, et al. (2014), whether games have effects on mathematics achievement of

students, they found out that results indicate a statistically significant effect of the program on students' basic number sense skills as measured by a standardized measure of mathematics achievement.

According to Treher (2011), a growing body of research proves that properly designed team-based board games not only inspire learning, they encourage communication, collaboration and risk taking. They empower players by helping to build self-confidence. The different elements of game design support a wide range of player abilities, and learning translates to behaviour changes.

Attitude Towards Mathematics

Bonto (1991) mentioned the findings of Aquino that one of the causes affecting mathematics is lack of understanding of problems.

Another factor that affects the performance in mathematics is the attitude towards the mathematics. Padilla (2008) mentioned in his study that most students considered mathematics as extremely difficult. The findings of Bonto (1991) are similar to the findings of Padilla (2008). Bonto (1991) found out that both grades V and VI pupils choose Mathematics as most difficult and hated subject, followed by Science, English and Music. Filipino is their easiest subject. Lariego (1990) revealed in his study that students' attitudes toward mathematics are significantly related to the performance in mathematics.

Ayson (1982) also found out that attitudes towards schoolwork affect the performance. She then recommended that teachers should inculcate in their students wholesome, positive attitude towards schoolwork. This is also similar to the findings of Banggawan (1997) academic performance in mathematics is affected by the student's own attitude towards the subject.

On the other Villanueva (1993) found out that a contradicting result from the studies of Lariego (1990), Ayson (1982) and Banggawan (1997). Villanueva (1993) revealed in her study that student's academic performance in mathematics is not significantly related to their study habits and attitudes, while academic performance in English as a subject has a significant correlation with the student's study habits and attitude. This is supported by the study of Oscillos (2006) which revealed that students' attitudes towards mathematics were not significantly related to the performance.

Use of instructional Games

For some students, going to school every day is a constant struggle. Some face the struggle to stay awake through their boring classes and some because it is just plain frustrating to learn in a way that does not excite them or make them engaged at all (Sierrasu, 2013). There are several ways to make learning meaningful and interesting, one way to is by incorporating educational games in the lesson.

A study conducted by Huang, et al. (2014), suggest that centering on the daily life experiences of learners, integrating a proper game model into mathematics learning and providing a diagnostic mechanism prompt can effectively enhance interest in learning mathematics and reduce anxiety.

Games are a regular part of students' lives, no matter what their grade level is. Students play games throughout the day on their computers, the Internet, and their cell phones. One of the few places which they don't regularly play games is in their classrooms. Although some teachers use games as a part of their instructional repertoire, most teachers do not, and those who do include them may not be using them to their full potential (Marzano, 2010).

Games teach or reinforce many of the skills that a formal curriculum teaches, plus a skill that formal learning sometimes, mistakenly, leaves out – the skill of having fun with math, of thinking hard and enjoying it (Adama, 2014).

Games provide an excellent environment to explore ideas of computational thinking. The fact that many games are available both in a non-computerized form and in a computerized form helps to create this excellent learning environment. A modern education prepares students to be productive and responsible adult citizens in a world in which mind/brain and computer working together is a common approach to solving problems and accomplishing tasks (Moursund, 2006).

The use of mathematical games in teaching and learning encourages discussion between students as they discover new mathematical concepts and develop thinking abilities (Applebaum and Freiman, 2014; Baek et al., 2008; Bragg, 2007).

According to Oldfield (1991), mathematical games are 'activities' which: (1) involve a challenge, usually against one or more opponents; (2) are governed by a set of rules and have a clear underlying structure; (3) normally have a distinct finishing point; and, (4) have specific mathematical cognitive objectives.

The following hypotheses were developed: H1: There is a significant difference between the attitude of students before and after using instructional games; H2: There is a significant difference between the pretest and posttest scores of students before and after using the instructional games; and H3: There is a significant relationship between attitude and performance in mathematics after using instructional games.

MATERIALS AND PROCEDURE

This study focused only on identifying the effects of instructional games on the attitude and performance in mathematics of Grade 7 students. A group of 40 students from public secondary school in the Division of Catanduanes was used as participants of the study. A one-group pretest-posttest design was used as the research method of the present study.

The topic which was included for the use of instructional games came from Geometry: (1) Basic Concepts and Terms in Geometry, (2) Angles, (3) Polygons, (4) Triangles, (5) Quadrilaterals, and (6) Circles.

There were total of ten sessions conducted when instructional games were used by the students. Instructional games were used during the third grading period. Questions given during the enrichment activity game came from the lessons discussed by the class during their math class.

The researcher designed a 100-item test based on the Table of Specifications (TOS) made by the researcher. The topic included was Geometry which was the whole chapter in the third grading period of Grade 7. TOS was prepared based on the competencies set for the Chapter Geometry. The designed TOS was presented to grade 7 mathematics teaches of Catanduanes National High School for validation purposes. After the verification of the designed TOS, the drafting of the 100-item test followed. The drafted test will be utilized for pretest and posttest.

The drafted test was item analysed to identify items that will be retained. These retained items will consist the test which will be utilized for pretest and posttest.

It was found out that the reliability factor for the instrument to be used for determining the performance in mathematics was 0.81. This means that the instrument is highly reliable (Calmourin & Calmourin, 2007).

The second instrument used is the CAToMS or Catandunganon Attitude towards Mathematics Scale which was developed by Antonio (2020). CAToMS is a 27-item attitudinal scale that was designed and validated specifically for Catandunganon students. CAToMS was used to determine the attitude of the students towards mathematics before and after using instructional games.

There are positive and negative statements rated through the 6-point Likert scale with options ranging from "very strongly agree" to "very strongly disagree." The weighted mean value of the item was computed to determine whether the students have positive or negative attitude towards mathematics before using instructional games.

Responses to negatively worded statements were reversed before the inclusion in the computation of general weighted mean of each category. For example, if 1 or VSD (Very Strongly Disagree) was selected, the numeric value would be changed to 6 or VSA (Very Strongly Agree). If 4 or A (Agree) was selected, the numeric value would be changed to 3 or D (Disagree) (Fadali, 2004).

The computed Cronbach's alpha of CAToMS was $\alpha = .88$ which suggested a high reliability coefficient factor (Antonio, 2020).

RESULTS AND DISCUSSIONS

Attitude of students towards mathematics before using instructional games

Attitude of students towards mathematics is affected by different factors. In this study, these factors affecting their attitude towards mathematics will not be discussed. The study was designed only to determine whether instructional games have some effects on the attitude towards mathematics of Grade 7 students in Catanduanes National High School.

Item no. 22 states that "*Topics in mathematics are interesting and they are important in our daily lives,"* has the highest weighted mean which is $\bar{x}$ = 5.43 or 5 (Strongly Agree). It means that students have a strong positive attitude toward the importance of mathematics in daily lives.

This is supported by item no. 11, which states that "*Mathematics classes provide opportunities to learn values that are useful in other parts of daily living,"* as the second highest weighted mean, with mean of $\bar{x}$ = 5.40 or 5 (Strongly Agree). It means that students have a strong positive attitude towards the usefulness of mathematics.

Furthermore, students strongly disagree in item no. 10 which states that *"Mathematics is a boring subject."* It has a weighted mean of $\bar{x}$ = 5.38 or 5 (Strongly Disagree).

Only few students agree to item no. 26, which states that *"I find topics in mathematics are very broad that I could hardly learn and understand."* It has a weighted mean of $\bar{x}$ = 3.5 or 3 which is "agree." Students agree to item no. 8 which states that "*I need someone to guide in solving problems because it confuses me."* It has a weighted mean of $\bar{x}$ = 3.25 or 3 which is agree.

In addition to this, students do not agree that Mathematics is considered one of the most difficult subjects as reflected by the weighted mean of item no. 21 which is $\bar{x}$ = 3.00, or "agree."

The general weighted mean of the attitude towards mathematics before using instructional games is $\bar{x}$ = 4.50 or 4. This is equivalent to a qualitative response agree. This means that students have a positive attitude towards mathematics before using instructional games.

Attitude of the students towards mathematics after using Instructional Games

After the students used instructional games, they were asked to answer the same survey questionnaire they had answered before using the instructional games. Through this, the researcher was able to determine whether there is a change in their attitude towards mathematics or there is none.

Item no. 22 *"Topics in mathematics are interesting and they are important in our daily lives,"* has now a weighted mean of $\bar{x}$ = 5.50 or 5 (Strongly Agree). This is an increase of 0.17 point as compared to their attitude before using instructional games.

Item no 11, *"Mathematics classes provide opportunities to learn values that are useful in other parts of daily living,"* has no change in the weighted mean, still it has a weighted mean of $\bar{x}$ = 5.40 or 5, a "strongly agree." Item no. 10 "*Mathematics is a boring subject,"* has now a weighted mean of $\bar{x}$ = 5.03 or 5, a "strongly disagree." There is a decrease of 0.35 point.

Item no 26 which states that "*I find topics in mathematics are very broad that I could hardly learn and understand."* It has now a weighted mean of $\bar{x}$ = 3.20 or 3, but still has a qualitative response of "agree."

The number of students who recognized that they need someone to guide them in solving problems decreased as reflected on item no. 8 "*I need someone to guide in solving problems because it confuses me,"* with a weighted mean of $\bar{x}$ = 3.40 or 3, or "agree." But there is a decrease in the number of students who recognize that mathematics is a difficult subject as reflected in item no. 21, with a weighted mean of $\bar{x}$ = 4.90 or 5, or "strongly disagree."

The general weighted mean of the attitudes of students towards mathematics after using instructional games is $\bar{x}$ = 4.71 or 5 which is equivalent to a qualitative response of "strongly agree." This suggests that students have a strong positive or favourable attitude towards mathematics after using instructional games.

This general weighted mean after using instructional games is 0.21 point higher as compared to the general weighted mean before using instructional games which is $\bar{x}$ = 4.50. Although there is a slight increase in mean, it needs to be tested for difference first to see if the change of attitude is significant or not.

Difference in the attitude of students towards Mathematics before and after using Instructional Games

The general weighted mean of the attitudes before and after using instructional games has a slight difference. To tell that the weighted means significantly differ, it needs to be tested first.

The test statistic used for this data was *chi-square test.* Table 1 shows the summary result of the test of difference in the attitude of students towards mathematics before and after using instructional games.

After computing the test statistics of the difference of the attitude before and after using instructional games, the computed value was 5.479– which is lower than the tabular value 16.919 with 9 degrees of freedom. With this, the null hypothesis is accepted and therefore there is no significant difference in the attitude towards mathematics before and after using instructional games

Table 1: Test of Difference on the Attitude of Students towards Mathematics

Variable	Test-Statistic	Comp. Value	Tabular Value	df	Decision	Interpretation
Attitude of students towards math before and after using instructional games	Chi-square test	5.479	16.919	9	Accept Ho	There is no significant difference.

This shows that after using instructional games, students' attitudes toward mathematics have not changed. Hence, instructional games do not have any positive effect on students' attitudes toward mathematics.

Before using instructional games, item no. 1 which states that *"I believe that if I work long enough on a mathematics problem, I will be able to solve it,"* has a weighted mean $\bar{x}$ = 4.35 or 4 (Agree). After using instructional games, the weighted mean becomes $\bar{x}$ = 5.35 or 5, a "strongly agree" or strongly positive attitude. Item no. 5 which states that *"I want to concentrate more in math than in any other class,"* has a weighted mean of $\bar{x}$ = 4.05 or 4 (Agree) before using instructional games. However, after using it, the weighted mean becomes $\bar{x}$ = 4.58 or 5, a "strongly agree" response. Respondents agree to the statement *"Studying mathematics in school is enjoyable and interesting,"* in item no. 12 with a weighted mean of $\bar{x}$ = 5.35 or 5 (Strongly Agree). After using it, the weighted mean becomes $\bar{x}$ = 5.50 or 5 (Strongly Agree).

Respondents disagree to item no. 9, which states that *"Mathematics is a difficult subject,"* with a weighted mean $\bar{x}$ = 4.50 or 4 before using instructional games. After using it, the weighted mean becomes $\bar{x}$ = 3.88 or 4, which is also "disagree." This is supported by item no. 10 that "*Mathematics is a boring subject,"* with a weighted mean $\bar{x}$ = 5.38 or 5 (Strongly Disagree) before using instructional games. After using it, the weighted mean becomes $\bar{x}$ = 5.03 or 5, or "strongly disagree." This is also supported by the statement "*I like mathematics,"* with a weighted mean of 4.58 or 5 (Strongly Agree) before using instructional games. After using instructional games, the weighted mean becomes 5.43 or 5 (Strongly Agree).

Performance in Mathematics of Students before Using Instructional Games

Pretest mean score is the indicator of the performance in mathematics before using instructional games. Before the students use instructional games, they were asked to answer the achievement test made by the researcher. This determined the pretest mean score of students before using the instructional games. Figure 1 shows the performance of the students before using instructional games.

As seen in figure 1, the performance of students before using the instructional games is 19.92. From a 40-item pretest, this mean score was categorically low, being below the 50 per cent of the total number of items. This tells that the class found the test a difficult one. The median and mode of the class are both 20, which is halfway the total number of items. The standard deviation which was 3.90 indicates that the scores of the students are close to one another.

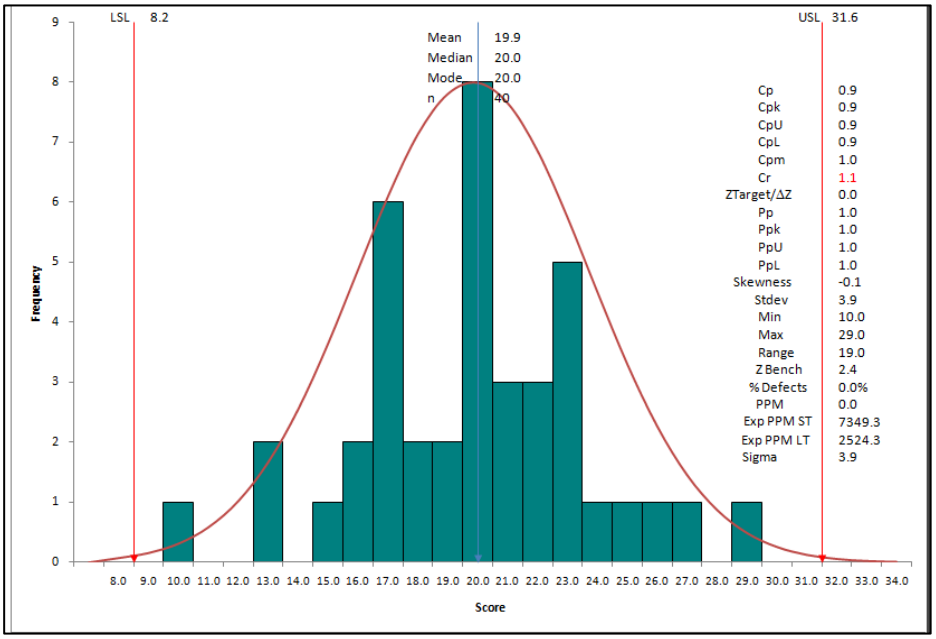

Figure 1: Performance of Students before using Instructional Games

Performance in Mathematics of Students after using Instructional Games

Posttest mean score is the indicator of the performance of students after using instructional games. After the students used instructional games, they were asked to answer the protest. Figure 2 shows the performance of the students after using instructional games. The posttest mean score of the students after using the instructional games was 25.94. The median is 27 and the mode is 28, which were both above 50 per cent of the total number of items. With its 4.08 standard deviation, the students' scores are said to be close to each other.

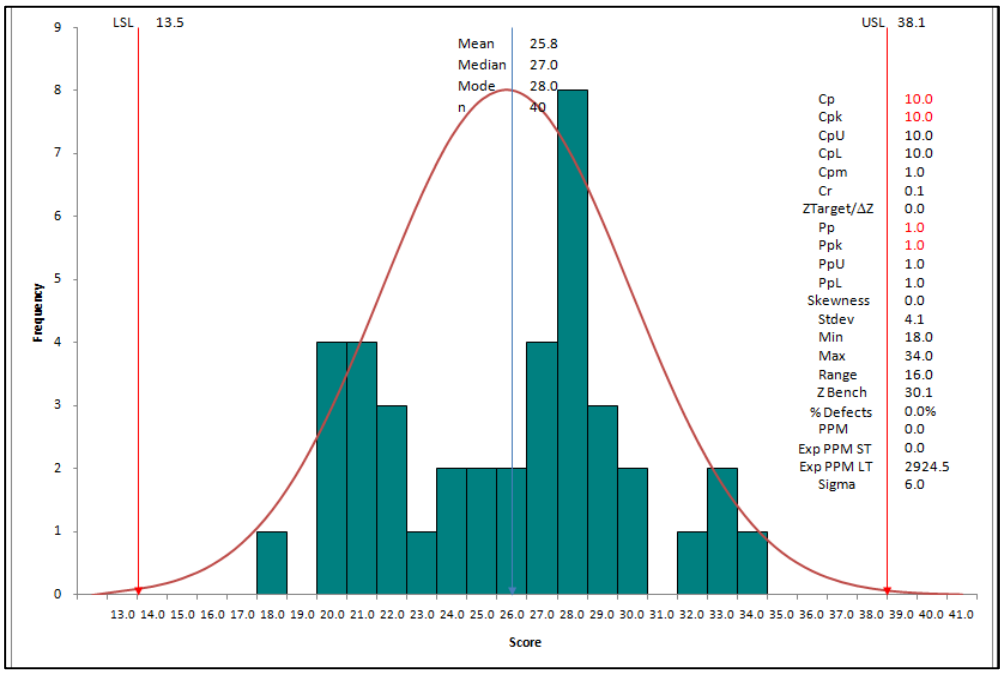

Figure 2: Performance of Students after using Instructional Games

Difference in the Performances of Students before and after using the Instructional Games

The performances of the students before and after using instructional games were not the same. However, it could not immediately be concluded that the performances were significantly different. There is a need to test the difference of the two performances. It is important to test the difference to conclude whether instructional games had some effects on the performance of students in mathematics after using it.

The two means which are 19.92 and 25.94 in pretest and posttest, respectively, were compared and tested. It is strikingly seen that pretest mean score is lower than the posttest mean score. Using t-test for paired samples, it could be determined whether the two means are significantly different or not.

Using paired t-test, hypothesis was tested if there is no significant difference between the performances of students before and after using the instructional games.

Below is table 2 that shows the summary result of the difference between the performance of students before and after using the instructional games.

Table 2: Test of Difference between the pretest and Posttest Scores of Students

Variable	Test-Statistic	Comp. Value	Tabular Value	df	Decision	Interpretation
Pretest and posttest score	Paired t-test	8.330	2.021	39	Reject Ho	There is a significant difference.

The computed value 8.33 is greater than the tabular value 2.021, therefore the null hypothesis is rejected, and it is concluded that there is a significant difference between the pretest and posttest mean scores of students before and after using the instructional games. It means that the performance in mathematics of students had increased after using the instructional games. It could also be concluded that instructional games have a positive effect towards the performance of students in mathematics.

Before using instructional games, students' performance in mathematics is 19.92. On the other hand, after using mathematics it increased to 25.94. The median and mode before using instructional games were both 20, while after using instructional games the median and mode become 27 and 28, respectively. Before using instructional games, the standard deviation was 3.90, and then it becomes 4.08 after using instructional games.

Relationship between Attitude and Performance in Mathematics of Students after using Instructional Games

According to Lariego (1990), Mathematics and students' attitudes towards mathematics were significantly and positively related to the achievement in subject which is contradicting to the study of Oscillos (2006) which she revealed that students' attitudes toward mathematics were not significantly related to the performance in mathematics.

This study hypothesized that there is no significant relationship between the attitude and performance in mathematics of students after using instructional games. To test this hypothesis, a chi-square test and Cramer's coefficient was used.

Table 3 shows the result of the test of relationship between the attitude and performance in mathematics of students after using instructional games.

Result of the test of relationship between attitude towards mathematics and performance in mathematics after

using instructional games shows a significantly low relationship. It means that the attitude towards mathematics is related to the performance of students in mathematics.

Table 3: Test of Relationship between Attitude and Performance in Mathematics of Students

Variable	Test-Statistic	Comp. Value	Tabular Value	df	Decision	Interpretation
Attitude and Performance in Mathematics	Chi-square test Cramer's Coefficient	8.163 0.32	5.991	2	Reject Ho	There is a significant with low relationship

CONCLUSIONS

Games that are used in instruction could have two different effects on the students. It could enhance the learning outcome or worsen. There is a need to properly integrate instructional games in the teaching-learning process.

Results have shown that the use of instructional games improved the performance in mathematics of the students, but it did not improve the attitude of the students towards mathematics. There could be reason why this instructional game did not improve the attitude of the students.

Results also showed that attitude towards mathematics have a positive significant relationship to the performance in mathematics.

LIMITATIONS OF STUDY

Since this is only an action research, there are limitations to this study. One of these is the small number of participants used in the study. A larger number of participants could yield a better result particularly in determining the effect of the board game to the attitude towards mathematics. Future studies that will test the relationship of attitude and performance in mathematics are encouraged.

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