

EFFECTIVENESS OF SCI-MATH BOARD GAME FOR ELEMENTARY SCIENCE AND MATHEMATICS

ABSTRACT

This study aimed to determine the effectiveness of Sci-Math Board Game for elementary learners in terms of learners' academic performance in Science and Mathematics of the 20 Grade VI learners from Tuyangan Elementary School in Tuyangan, Kabugao, Apayao. This was carried out during the school year 2021-2022. The Researcher made use of quasi-experimental research. Result showed that in the teaching and learning process, using Sci-Math Board Game is effective, especially in teaching science and math. Board games allow for various interactions that result in players engaging in computational thinking, teamwork, and creativity. Furthermore, the Science and Mathematics performance of the participants showed that there is a significant difference after using the Sci-Math Board Game as instructional tool.

Keywords: Science, Mathematics, performance, Sci-Math Board Game, instructional tool

1. INTRODUCTION

Most 21st century learners are getting addicted to mobile games such as strategy, educational, and arcade. Though these games are addicting, there are still addictive and fun traditional games too, to play with. One of these traditional games is a board game like chess, scrabble, Chinese checkers and snake and ladders which provides an effective tool for teachers to get the attention of their learners during the teaching and learning process.

Board game is an exciting competition game which uses tokens that are moved or set to mark the movement of players which corresponds to the rules of the game [1]. In traditional methods of teaching, it is very difficult to get the attention of today's learners. However, board games can be an effective instrument to encourage children to acquire knowledge and showcase their skills through creativity, concentration, self-confidence, competitiveness, and crave for improvement by means of exploration and experiential learning [2][3]. Board games are designed which encompasses either technique and fortunes. These kinds of game typically have objectives that players wish to attain [1]. Board games anchored with learning competencies can be used as teaching tools [4]. Learners can acquire knowledge productively through experiential learning [5]. Educational board game lets children acquire knowledge actively [6]. These games are regarded effective, innovative and interactive alternatives to supplement standard educational practices because they motivate children, boost learning, make learning entertaining and foster teamwork [7]. These games can be used by educators to go over with the previously covered materials and introduce new ideas [5]. Furthermore, educational board games help children build friendships, strong parent-child relationship, social skills and development [8][9][10][11][12].

Moreover, using board games as a teaching tool encourages students to acquire new concepts, enhance their academic performance, and enjoy learning activities without feeling threatened. [13] DepEd Order No. 32 s. 2015 has endorsed the need for new instructional materials. Page 15, 16 under Key Elements of an Indigenous Peoples Education Curriculum,

Number 4 in 2015, which recommends the use of the IPEd Framework. "Learning Resources - Instructional Materials and other learning resources must be created and used in conjunction with the curricular interaction and teaching-learning process specified." This was supported by the [14] Republic Act 10533: Enhanced Basic Education Act of 2013 under Section 5, Item H Under Curriculum Development which stated that "The curriculum must be flexible enough to allow and encourage schools to innovate, localize, indigenize, and improve them according to their educational and social settings. The development and production of locally created learning and teaching materials would be promoted, with approval devolved to regional and division education units."

Furthermore, the creation of instructional materials is guided through [15] DepEd Order No. 76 S. 2011 National Adoption and Implementation of LRMDS "The LRMDS Framework serves as the guideline instrument for the implementation and ongoing operation of LRMDS at all levels of DepEd. It is supported by guidelines and process documents for all sub-systems, a quality assurance framework, standards and specifications"

In addition to this, [16] DepEd Memo No. 82 S. 2017 supported the LRMDS as a system designed to support increased distribution and access to learning, teaching and professional development resource at all levels of DepEd.

COVID-19 pandemic has highly affected our society because of health risks which may lead to danger. One of the affected sectors was education and it resulted to the interruption of classes in order to avoid the spread of the virus. The pandemic has made distance learning inevitable not only in urban areas but also in rural areas of the country. Despite of these challenging situations, the Department of Education decided not to delay education and has therefore introduced alternative learning modalities using modern technologies and modules. to continue the classes. Schools shifted from traditional face-to-face way of teaching to distance learning approach. DepEd coined the term distance learning, "where the learning takes place between the teacher and the student who are geographically distant from each other." [19].

Despite of this COVID-19 pandemic Tuyangan Elementary School, opened the school year 2021 - 2022 using modular distance learning approach which suits to the geographical environment of the school, and a new way of teaching-learning process for the teachers and also the learners of the said school. The modular approach placed the learners to learn in the comfort of their homes, limits the contact to teachers and parents or guardians take place as their model.

Though limited face-to-face is being implemented, teachers found out that learners' academic performance decline due to more than a year of remote learning especially in Science and Mathematics where teachers guidance is highly needed.

Back to school teaching and learning, on the other hand, was expected to add to the difficulty of learning mathematics and science, which were perceived to be difficult by many students. As a result, it became critical to develop instructional materials to bridge the gap between the teaching and learning of mathematics and science in this constrained face-to-face setting. This was based on Section 5 of the [14] Enhanced Basic Education Act of 2013, Item H, Curriculum Development, which states that the curriculum must be flexible enough to enable and allow schools to localize, indigenize, and enhance it based on their respective educational and social contexts. It will be encouraged to create and develop locally created learning and teaching resources, and approval of these materials shall devolve to the regional and division education units.

While recognizing the fact that the entire education system is affected, special attention in this study has been given to mathematics and science. This is because students' performance in mathematics and science has been extremely low even before the COVID-19 outbreak not only in the locality and but also in some part of the country and around the world as well.

At the onset of limited face-to-face, these problems reminded us of the need for intervention to teach mathematics and science in a fun way.

With this background, it was necessary to find out other teaching materials to help students learn the concepts and the know-how of mathematics and science during the limited face-to-face.

2. MATERIAL AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

Research Design:

The quasi-experimental research design was used in this study. The quasi-experimental research is research of which the independent variable was manipulated, participants are not randomly assigned to conditions or orders of conditions [20]. Quasi-experiments are often conducted to evaluate the effectiveness of a treatment or educational intervention. Specifically, the pretest - post-test quasi-experimental design was used in this study. The dependent variable was measured twice in this design: once before and once after the treatment was implemented. Single group experimental is shown below.

O_1 x O_2

Where:

O_1 - is the pretest scores
 X - is the experimental treatment, the use of Sci-Math Board Game
 O_2 - is the post-test scores

In experimental research, there were two variables that had correlation each other. Variable was an object of study that became important points in research. In this research there were two variables:

1. Independent variable
In this research, the independent variables are Participant's Profile and Sci-Math Board Game
2. Dependent variable
Dependent variable was observed or measured to determine whether a change or variation in the independent variable causes or effects a change in the dependent variable. In this research, the dependent variable was learners' gain score.

Locale of the Study

Tuyangan Elementary School is a Child Friendly School which caters all grade school levels (K – Grade 6) in the barangay. The school was located in the center part of the barangay between Baliwanan Broke and Apayao River where some learners need to cross the said rivers to seek for education. In some cases when there is a typhoon, some learners can't attend to their classes.

The Tuyangan Elementary School began its historic past in the year 1960's as Tuyangan Primary School through Mr. Semerte Basang Bruno.

Mr. Bruno back to worrying, not only about his kids but to all community children who grows illiterately. Parents were sending their children to Dibagat or Baliwanan which is 2 kilometers away from Tuyangan (the neighboring barangay of Tuyangan where education can be accessed) but children opt not to go sometimes due to the distance. It is far and inaccessible to people. If there is no banca/boat you need to hike for 29 kilometers from the center of trade and industry in Poblacion, Kabugao this is the reason why absenteeism is very high and low performance of learning takes place.

So, Mr. Bruno went to Kabugao District to ask for teacher who will start or open a school in Tuyangan.

In response to the request, the primary school began to operate with only one teacher named Mrs. Nena C. Dangel. The primary school started in a private house as a temporary classroom to house its first batch of learners.

As years goes by, Tuyangan Elementary School grew. This improvement could be seen through the number of buildings constructed, an increase of enrolment as well as school personnel, Mrs. Sabas Bermudes and Mrs. Calummad Bordad. Then the first building was the PTCA building erected in the year 1960's. The walls, roofs and floor of the building were made out of bamboo and woods.

In 1963, a parcel of level land which measures about one-hectare square meters was donated by Mr. Poloypoy Bogalic for the establishment of the school building bounded on the north by property of Linda Bogalic on the west by property of L. Bagayao, on the east by property of L. Bogalic and on the south by the Apayao River under the real property declaration no. 3305 in the office of the municipal treasurer, Kabugao, Mountain Province. (Deed of Donation, 1963).

After several months, they transferred again to the constructed permanent building funded by the government.

Today, children are now learning with sweet smiles. With not so much ado, we can proudly say that Tuyangan Elementary School is matured enough at its 59 years serving the community of Tuyangan, but needs support from the government in order to address the needs of teachers and learners for better teaching and learning process and to produce globally competitive learners. We are hoping for its continuous development.

Participants and Sampling Procedure

The participants of this study were 20 grade six learners who were currently enrolled in Tuyangan Elementary School. They were asked to accomplish the questionnaire on their socio-demographic profile which includes the following: age, sex, educational attainment of mother, educational attainment of father, monthly income of mother, monthly income of father, number of brothers, number of sisters, and GPA in grade five mathematics and science subject.

Their level of performance in mathematics and science was identified through their permanent record of grades or form-137-E.

Total enumeration is used in order to get the validity of the respondents.

The Form 137-E, researcher-made questionnaires, Sci-Math Board Game, and researcher made multiple choice questionnaires were the instruments used in gathering the needed information or data in this study.

I. Form 137-E

To obtain the level of performance of the learners, DepEd form 137-E was used. This form was also known as the elementary learners' permanent record. It contains the following information: students' name, place of birth, parents/ guardian, transferred in/out (school), total number of years to complete elementary course, general average of the learner in her/his grade level studies and the school year he/she entered the school. In this form also are the data about the learner's curriculum year, grades from the different subjects prescribed in every curriculum year from Kinder to grade VI, periodic rating, the average in every subject they have taken, the remarks "passed" or "failed", and the credits they earned in a particular subject. It also included the month, days of school, and the days that the student attended school in every curriculum year.

II. Researcher-made Questionnaires

The data on demographic profile of the participants were obtained using researcher-made questionnaires. The grade in grade five mathematics and science of the participants was obtained from the form-137-E or the permanent records of grades of the participants.

III. Sci-Math Board Game

The Sci-Math Board Game developed by the researcher which was used and integrated in teaching the identified learning competencies in science and mathematics for Grade VI. It was patterned from the Snake and ladder board game and laid out from adobe photoshop. It was validated and tried out in 2015 by 15 grade six learners, three teachers and one principal of Pudtol District who are expert in math and science. The figures below show the developed board game and other materials needed in using it like the dice and tokens/counters.

The Game and its Rule

1. About the Game:

The game is similar to and patterned after the snakes and ladders board game. Only math and science concepts are intended in the game.

2. The goal of the game

The aim of the game is to reach the final square from the starting square on the board before anyone else (any other player)

3. How to start the game

The game will start by means of tossing a die. The winner of the tossing of the coin will be the first one.

4. Number of Player

The game consists of four players. The first player to set the board will be determined through rolling a die. The player who has the greater number of appearing in a toss will be the first one. The first player to roll the die with spot 1 can enter the board (sometimes 6). Each succeeding player must also toss a 1 to 6 to enter the board. A die must be rolled again to show the number of squares that the player entering the board may move initially. Place the marker on the right square. Each player may only roll the die once.

5. Continue Playing:

Each of the players will take a go. The person with the highest number starts first. The second highest goes next and so on. But do not move the counter.

Science Concept

a. Junk Foods/non-biodegradable/non-renewable:

- If a player lands at the junk food, his/her marker slides down to the square where malnourished kid is or sad earth.

b. Nutritious Foods/biodegradable/renewable:

- If a player lands at the nutritious foods his/her marker moves to the square where healthy kid is or happy earth.

Mathematics Concept

a. Mathematical Operation:

- If a player lands on a mathematical operation, the player must solve the given mathematical sentence first before he or she moves his/her marker.

b. Winning the Game:

- The player who manages to be the first person to reach the top/final square on the board (usually the number 100) wins.

Figure 1 Sci-Math Board Game: Nutritious vs Junk Foods

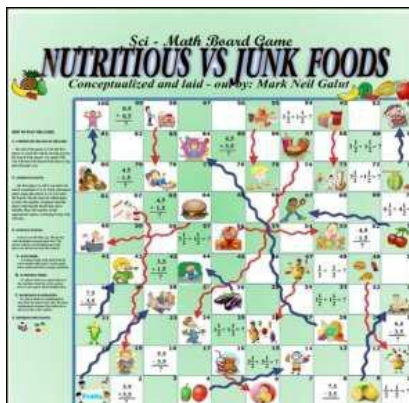


Figure 2 Sci-Math Board Game: Biodegradable vs non-biodegradable



Figure 3 Sci-Math Board Game: Renewable vs Non-renewable

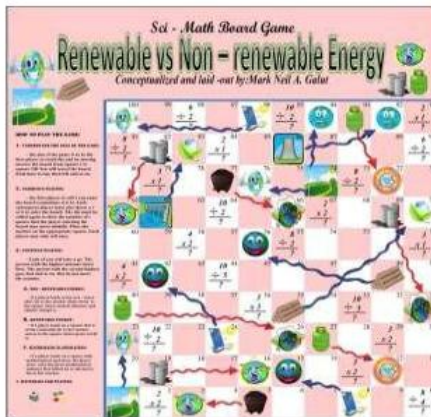


Figure 4 Tokens/Counters



Figure 5 Die/Dice



IV. Researcher-made Science and Math Questionnaires (Pretest/Post-test)

This is a researcher-made instrument designed to measure the achievement of learners in Math and Science VI. It was administered to the group on a pretest and post-test basis. It consisted of 50-item (25-item Mathematics and 25-item Science) on the following learning objectives in Mathematics (1. adds and subtracts simple fractions and mixed numbers without or with regrouping, 2. multiplies simple fractions and mixed fractions, 3. divides

simple fractions and mixed fractions, 4. adds and subtracts decimals and mixed decimals through ten thousandths without or with regrouping, 5. multiplies decimals and mixed decimals with factors up to 2 decimal places, 6. multiplies mentally decimals up to 2 decimal places by 0.1, 0.01, 10, and 100, 7. divides whole numbers by decimals up to 2 decimal places and vice versa, 8. divides decimals up to 4 decimal places by 0.1, 0.01, and 0.001) [17] and Science (1. tell the benefits of separating mixtures from products in community - in relation to biodegradable and non-biodegradable waste materials, 2. explain how the organs of each organ system work together - in terms of foods taken, 3. demonstrate how sound, heat, light and electricity can be transformed - in relation to renewable and non-renewable energy) [18] which are incorporated in the board game.

The study was composed of three phases: phase 1 was the pre-experimental phase which is the preparation and validation of Table of Specification (TOS), Pretest/Post-test and Lesson Plans, phase 2 was the experimental phase which is the actual use, and testing for the effectiveness of the board game. The researcher used the board game as an instructional tool to in the different parts of the lesson during the delivery of the learning competencies and educational content of the subjects incorporated in the board game. Phase 3 was the conduct of posttest.

The following steps were used to test the effectiveness of the Sci-Math Board Game.

Phase 1: Pre-experimental Phase

Preparation and validation of Table of Specification (TOS), Pretest/Post-test and Lesson Plans

The researcher constructed a 40-item (20-item Mathematics and 20-item Science) multiple choice test. The test was carried out following the making of a specification table (TOS). A TOS is a test blueprint that demonstrates how the teacher developed exam questions. After the construction of test questions, the researcher asked the experts or the teacher who teach the topics and read through the questionnaires. They evaluated whether the questions effectively capture the topics under investigation. After the evaluation, the researcher validated the questionnaires to grade six learners in nearby schools. After the validation the 40 – item test questions became 50 – items (25 – items for science and 25 – items for math)

Subsequently, the researcher prepared lessons which covers the different learning objectives stated in research instrument no. 4 (Researcher-made Science and Math Questionnaires - Pretest/Post-test. Following the validation of the lessons by the experts in the subject.

a. Pretest

The pre-test was given to the participants in the second meeting. The pre-test was given by the researcher in order to determine or measure the prior knowledge of the learners. The material of pre-test was in the printed form, which contains some questions that need learners' mastery to answer the questions. Then, the result of pretest can show up after checking.

Phase II: Experimental Phase

In order to make the learners understand the lesson well as much as possible the researcher gave the treatment after the pretest. The treatment used in experimental was the Sci-Math

Board Game. It was used during four meetings. During the implementation of the validated lesson plans the Sci-Math Board Game was used in the following part of the lesson:

To begin, the researcher employed a board game (as motivation) to arouse learners' long-term interest in learning. The students were questioned about the causes and effects of each activity they took (English topic - DepEd encourages teachers to teach subject across learning areas). Second, during the session, the researcher used the board game to ensure that the learner comprehends the important concepts of their lessons. Third, the researcher urged the learners to apply what they had learned in the class into play (application) by playing a board game. After they concluded the game, the researcher asked them to answer an essay question as part of the lesson's evaluation, in which they were asked to explain the lesson on how they understood it through using the board game as an instructional tool in math and science.

Phase III: Post-Experimental Phase

The researcher gave a post-test at the last meeting after all of the lessons had been taught to check if the Sci-Math Board Game had improved the learners' math and science performance.

The learners took the post-test allowing them to apply what they had learned in class.

The scores from the two tests were compared after the post-test to see if there was a significant difference between them.

Statistical Treatment

In examining the effectiveness of the Sci-Math Board Game on the learners' performance in Science and Mathematics, the researcher utilized the following statistical treatment to interpret the data of the study effectively.

For Demographic Profile Analysis

Percentage. It was used to discover the frequency counts and distribution of percentages of personal profile of the participants. As explained by [21] Brown (2014) like fractions, percent are a way to represent parts of an entire. However, in percent one whole is always considered to be 100%. According to [22] Young (2019) frequency distribution is the portrayal of the numbers of the surveys within the given interval. Frequency distribution depends on the data being analyzed and objectives of the researcher.

Where:

$$P = \frac{F \times 100}{N}$$

P = Percentage

F = Frequency

N = Total Number of Respondents

For Pretest/Post-test Analysis

Mean. It was used to identify the evaluation of the participants based on their pretest/post-test. According to one study of [23] Martinez, (2019) it was stated that to get the mean the sum of all data entries must be divided by the number of entries. As explained by [24] Turner (2013) is a measure of central tendency that is most appropriately used for continuous data. The mean of a set of data points is defined as their sum divided by the total number of data points.

Formula: $x = \frac{\sum x}{n}$

Where: $x = \text{mean}$

$\sum x = \text{sum of all scores or values in distribution}$

$N = \text{total number of scores in the distribution}$

Standard Deviation. As stated by [25] Hargrave (2019) standard deviation is a figure that measures the distribution of the data related to the mean. It is calculated as a square root of the variance by determining the variance connecting to each data points that is related to the mean. This measure is used to specify how thoroughly the scores were congregated around the mean. According to [26] Bland (2006), the square root of the variance is called the standard deviation usually denoted by s . it is often shortened to SD. It is a measure of how numbers will spread out.

T-Test. It was first called Student's T-test and later on called t-test. T-test was used to point out whether or not the difference of the variables has no significant effect on each other. As explained by [27] Siegle (2019) t-test is used to determine when there is a significant difference between the mean of two tests. When the difference between the two tests averages being investigated, a t-test is used. In other words, t-test is used when there are two mean that are being compared. The t-distribution is a probability distribution similar to the normal distribution. It is commonly used to test hypotheses involving numerical data, [28].

Pearson correlation coefficient. It was used to determine the extent of relationship of the gain scores of the participants from the two tests and their profile.

The result of the computed relationship the gain scores of the participants from the two tests and their profile will be interpreted according to Pearson's scale that varies from +1 to -1. It will base from the following values.

3. RESULTS AND DISCUSSION

Participant's Profile

Table 1: Distribution of Participants in terms of Age

Age	Frequency (n= 20)	Percent
11	9	45
12	11	55
Mean	10	

Table 1 presents the distribution of participants in terms of age. As shown in in the table, 9 or 45% were 11 years old, and 11 or 55% were 12 years old. This finding shows that the Grade VI regular learners as recorded on the electronic Basic Education Information System (eBEIS).

Table 2: Distribution of Participants in terms of Sex

Sex	Frequency (n = 20)	Percent
Male	12	60

Table 2 shows that 12 or 60% of the participants were male while 8 or 40% were female learners. This finding indicates that most of the Grade VI learners were males, based on the enrolment data of the school on Learners Information System (LIS).

Table 3: Educational Attainment of the Fathers of the Participants

Educational Attainment	Frequency (n=20)	Percent
Elementary Level	12	60
Elementary Graduate	2	10
High School Level	2	10
High School Graduate	0	0
College Level	1	5
College Graduate	0	0
Vocational Course	1	5
Did Not Attend Schooling	2	10

In table 3, 12 or 60% of the fathers of the participants were elementary level, 2 or 10% were elementary graduates, 2 or 10% were high school level, 0 or 0% were high school graduate, 1 or 5% were college level, 0 or 0% were college graduate, 1 or 5% attended the vocational courses and 2 or 10% did not attend schooling. Most of the fathers of the participants were elementary level. It implies that tertiary institution in the area is not available.

Table 4: Educational Attainment of the Mothers of the Participants

Educational Attainment	Frequency (n=20)	Percent
Elementary Level	5	25
Elementary Graduate	2	10
High School Level	3	15
High School Graduate	0	0
College Level	1	5
College Graduate	1	5
Vocational Course	2	10
Did Not Attend Schooling	6	30

The results in Table 4, show that 5 or 25% of the mothers of the participants were elementary level, 2 or 10% were elementary graduates, 3 or 15% were high school level, 0 or 0% were high school graduates, 1 or 5% were college level, and 1 or 5% were college graduate, 2 or 10% attended vocational courses. Most of the mothers of the participants did not attend schooling. It implies that the Filipino values/ culture of women to stay at home still exists in this area. Education for women is not a priority.

Table 5: Monthly Income of Parents of the participants

Income (In Pesos)	Frequency	Percent
20,001 - Above	0	0
15,001 - 20,000	0	0
10,001 - 15,000	0	0
5,001 - 10,000	1	5

As shown in table 5, 19 or 95% of the parents of the participants had an income of ₱5,000 and below, 1 or 5% had an income of ₱5,001-10,000, 0 or 0% had ₱10,001-15,000 income, 0 or 0% had an income of ₱15,001-20,000, and 0 or 0% had above ₱20,001 monthly income. Most of the parents of the participants had a monthly income of ₱5,000 and below, this implies that their monthly income is below poverty line.

Table 6: Occupation of Participants' Parents

Parent's Occupation	Frequency (n=20)	Percent
Government Employee	0	0
Self Employed	1	5
Farming	19	95
Overseas Filipino Worker	0	0
Not Working	0	0

As shown in table 6, 0 or 0% of the of the participants' parents had no work, 0 or 0% were OFW, 19 or 95% were farmers, 1 or 5% were self-employed, and 0 or 0% were government employee. Most of the participants' parents were farmers. This implies that the area is an agricultural community.

Table 7: Number of family members of the Participants

Number of Siblings	Frequency	Percent
0	0	0
1-3	0	0
4-6	12	60
7-9	8	40
Total	20	100

It is shown in table 7 that 8 or 40% of the learners' participants have 7-9 family member, 12 or 60% have 4-6, 0 or 0% have 1-3. This means that most of the participants belongs to the average number of household members of the family.

Table 8: GPA of the Grade VI Learners in their Grade V Mathematics

GPA Grade V	Frequency	Percent
Outstanding (90 – 100)	0	0
Very Satisfactory (85 – 89)	0	0
Satisfactory (80 – 84)	11	55
Fairly Satisfactory (75 – 79)	9	45
Did Not Meet Expectations (Below 75)	0	0
Total	20	100
Mean	79.75	

The data shown in Table 8 reveals that 9 or 45% of the Grade VI learners got a General Percentage Average in their grade five math of Fairly Satisfactory (75 – 79), and 11 or 55% got a GPA of Satisfactory (80 – 84). Most of the Grade VI learners got Satisfactory (80 – 84), GPA in their Grade V math, while only few of them got the GPA of Fairly Satisfactory (75 – 79). These figures show that generally, the participants have Satisfactory (80 – 84) in their

grade V mathematics. The general average is 79.75 which is fairly satisfactory. This implies the need of an alternative learning (remediation) to improve their performance.

Table 9: GPA of the Grade VI Learners in their Grade V Science

GPA Grade V	Frequency	Percent
Outstanding (90 – 100)	0	0
Very Satisfactory (85 – 89)	0	0
Satisfactory (80 – 84)	6	30
Fairly Satisfactory (75 – 79)	14	70
Did Not Meet Expectations (Below 75)	0	0
Total	20	100
Mean	78.50	

The data shown in Table 9 reveals that 14 or 70% of the Grade VI learners got a General Percentage Average in their Grade V science of Fairly Satisfactory (75 – 79), 6 or 30% got a GPA of Satisfactory (80 – 84), These figures shows that generally, the participants have Fairly Satisfactory (75 – 79), in their Grade V science. The mean of 78.50 implies the need of alternative learning approach to improve the performance of learners.

Table 10: Presentation of Data of the Experimentation on Mathematics

Participants	Pretest	Post test	Gain Score
1	7	12	5
2	9	20	11
3	7	14	7
4	8	13	5
5	7	15	8
6	9	14	5
7	6	13	7
8	9	14	5
9	10	16	6
10	10	19	9
11	11	17	6
12	6	15	9
13	12	18	6
14	4	13	9
15	9	19	10
16	8	15	7
17	7	19	12
18	11	20	9
19	8	17	9
20	8	15	7
Highest Score	12	20	12
Lowest Score	4	13	5
Mean	8.3	15.9	7.6
Standard Deviation	1.9	2.55	

Table 10 shows the scores in the pretest, post-test and gain scores of the learners in Mathematics, which means that for this set of scores, there is a difference between the pre-test (mean 8.3) post-test (mean 15.9) and gain scores (mean 7.6) while its standard deviation pre-test (SD 1.9) and post-test (SD 2.6) that is not likely due to chance.

Therefore, this implies that the use Sci-Math Board Game in some parts of the lesson may help learners understand their lessons and later on help them improve their performance and able to master the learning competencies at their grade level.

Table 11: Presentation of Data of the Experimentation on Science

Participants	Pretest	Post test	Gain Score
1	9	15	6
2	11	21	10
3	9	17	8
4	10	15	5
5	8	14	6
6	11	18	7
7	8	14	6
8	11	18	7
9	12	20	8
10	12	23	11
11	13	19	6
12	8	17	9
13	14	19	5
14	16	20	4
15	11	18	7
16	10	19	9
17	9	17	8
18	14	18	4
19	12	18	6
20	7	16	9
Highest Score	16	23	11
Lowest Score	7	14	4
Mean	10.75	17.8	7.05
Standard Deviation	2.36	2.31	

Table 11 shows the scores in the pretest, post-test and gain scores of the learners in science, which means that for this set of scores, there is a difference between the pre-test (mean 10.75) post-test (mean 17.8) and gain scores (mean 7.05) while its standard deviation pre-test (SD 2.36) and post-test (SD 2.31) that is not likely due to chance.

Therefore, this implies that the use Sci-Math Board Game in some parts of the lesson may help learners understand their lessons and later on help them improve their performance and able to master the learning competencies at their grade level.

Table 12: Mean, standard deviation and t-test of the pretest and post-test in Mathematics VI

Variables	Mean	Standard Deviation	Computed T	T Tab 5%	Decision
Pretest	8.3	1.9	16.3	1.29	Reject null hypothesis
Post-Test	15.9	2.55			There is significant difference between the pretest and post-test scores of grade six learners using the Sci-Math Board Game
Statistical Inference	Significant				

Table 12 shows the result of the pretest and post test scores of the learners in math. During the pretest, the learners did not use any board game in answering only the post test that they used the Sci-Math Board Game. It shows that the group obtained a higher post-test mean result of 15.9 compared to the pretest with the mean of 8.3. There is a mean difference of 7.6 between the scores before and after using the Sci-Math Board Game. This means that Sci-Math Board Game as a learning tool is effective in enhancing mathematics scores of learners. The findings of this study that the use of board game helps the learners concretize and understand abstract mathematical ideas which result to improved math scores are similar to [29] Sonnenschein et al. (2016). Based from the results, the Sci-Math Board Game is effective because the board itself is a representation that helps connect information. The design of the game is fused to subtle redundancies in order to enhance and ensure learning retention among players. Good questions, issues to be addressed and scenarios to contemplate encourage players to think about and apply what they've learned. When the participants play the board game, they were able to connect the lesson they've learned and strengthen the retention of the lesson through its visual features.

Before the intervention, the group had a standard deviation of 1.9 while after the intervention the group had 2.55. This shows that in their pretest, the group is more intact or homogenous than in their pretest.

Then the pretest and post test scores were subjected to directional t test, the computed value of t was 16.3. This value is more than the tabular value of t which is 1.3 at 5 percent level of significance. This means that the null hypothesis is rejected, thus, there is significant difference between their scores before and after using the Sci-Math Board Game.

This is supported by [30] Bayeck (2020) study, which found that board games are spaces for mathematical learning and learning spaces that can enable the learning of various contents. Board games allow for various interactions that result in players engaging in computational thinking, teamwork, and creativity.

Table 13: Mean, standard deviation and t-test of the pretest and post-test in Science VI

Variables	Mean	Standard Deviation	Computed T	T Tab 5%	Decision
Pretest	10.75	2.36	16.3	1.2	Reject null hypothesis
Post-Test	17.8	2.31			There is significant difference between the pretest and post-test scores of grade six learners using the Sci-Math Board Game

Statistical Inference	Significant
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On the other hand, Table 13 shows the result of the pretest and post test scores of the learners in science. During the pretest, the learners did not use any board game in answering only the post test that they used the Sci-Math Board Game. It shows that the group obtained a higher post-test mean result of 17.8 compared to the pretest with the mean of 10.75. There is a mean difference of 7.05 between the scores before and after using the Sci-Math Board Game. This means that Sci-Math Board Game as a learning tool is effective in enhancing science scores of learners. The findings of this study that the use of board game helps the learners understand concepts in science which result to improved science scores are similar to [31] Fjællingsdal, K. S., & Klöckner, C. A. (2020). Based from the results, the Sci-Math Board Game is effective because the board itself is a representation that helps connect information. The design of the game is fused to subtle redundancies in order to enhance and ensure learning retention among players. Good questions, issues to be addressed and scenarios to contemplate encourage players to think about and apply what they've learned. When the participants play the board game, they were able to connect the lesson they've learned and strengthen the retention of the lesson through it visual features.

Before the intervention, the group had a standard deviation of 2.36 while after the intervention the group had 2.31. This shows that in their post-test, the group is more intact or homogenous than in their pretest.

Then the pretest and post test scores were subjected to directional t test, the computed value of t was 16.3. this value is more than the tabular value of t which is 1.2 at 5 percent level of significance. This means that the null hypothesis is rejected, thus, there is significant difference between their scores before and after using the Sci-Math Board Game. The findings of the study are similar to those of [32] Chester, Davis, and Reglin (1991), [33] Cotter (200), [34] Sowell (1989), [35] Cramer et al, (2002), [36] Lackey and Reglin (1991), and [37] Tracy and Fanell (2000).

Moreover, this implies that the use of Sci-Math Board Game enhances the academic achievement of learners. The improvement of learners' academic achievement can be attributed to their interests on the board game. Furthermore, the notable increase in the academic achievement of the learners can be attributed to the intervention implemented.

This is supported by [38] Liu and Chen's (2013) study, which found that students felt that studying with an educational card game helped them obtain scientific information and that the game-based learning method boosted their interest in methods of transport and energy. The results of the post-test show that the card game significantly increased students' scientific knowledge of energy and means of transport.

Table 14: GPA of the Grade VI Learners in their Second Quarter in Mathematics

Second Quarter GPA	Frequency	Percent
Outstanding (90 – 100)	0	0
Very Satisfactory (85 – 89)	9	45
Satisfactory (80 – 84)	11	55
Fairly Satisfactory (75 – 79)	0	0
Did Not Meet Expectations (Below 75)	0	0
Total	20	100

Mean	84.25
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The data shown in Table 14 reveals that 11 or 55% of the Grade VI learners got a General Percentage Average in their second quarter math of Satisfactory (80 – 84), and 9 or 45% got a GPA of Very Satisfactory (85 – 89). Most of the Grade VI learners improved their GPA in their second quarter math. These figures show that generally, the participants have Satisfactory (80 – 84) improved in their second quarter. The general average is 84.25 which is satisfactory. This implies that continuous use of sci-math board game helps improves the learners' performance in math.

Table 15: GPA of the Grade VI Learners in their Second Quarter in Science

Second Quarter GPA	Frequency	Percent
Outstanding (90 – 100)	0	0
Very Satisfactory (85 – 89)	7	35
Satisfactory (80 – 84)	13	65
Fairly Satisfactory (75 – 79)	0	0
Did Not Meet Expectations (Below 75)	0	0
Total	20	100
Mean	83.75	

The data shown in Table 15 reveals that 7 or 35% of the Grade VI learners got a General Percentage Average in their second quarter science of Satisfactory (80 – 84), 13 or 75% got a GPA of Very Satisfactory (85 – 89), These figures shows that generally, the participants have Very Satisfactory (85 – 89), in their second quarter science. The mean of 83.75 implies the large improvement in the performance of learners.

Table 16: Correlation analysis of relationship between the gain score and profile of learners in Mathematics VI

Variable	r - value	Interpretation
Age	-0.28	weak negative relationship
Sex	0.19	no or negligible relationship
Family size	0.02	no or negligible relationship
Educational attainment of father	0.46	strong positive relationship
Educational attainment of mother	0.14	no or negligible relationship
Family income	0.38	moderate positive relationship
Occupation of Parents	-0.38	moderate negative relationship
Previous Grade	0.43	strong positive relationship
Present Grade	0.66	strong positive relationship

Table 16 shows that there was a strong positive correlation between the learner's father's educational level, previous grade, present grade, and gain score ($r = 0.46$, $r = 0.43$, $r = 0.66$). a weak negative connection ($r = -0.28$) between age and Participant gain score. The

occupation of the learner's parents was found to have a moderate negative correlation with gain score ($r = 0.38$). The learner's household income and gain score had a moderate positive correlation ($r = 0.38$). There was no other significant correlation between sex, family size, learner's mother's educational achievement, and gain scores ($r = 0.19$, $r = 0.02$, $r = 0.14$).

H_0 cannot be rejected since the p-value is $>$. The sample population's correlation is assumed to be equal to the expected correlation (0).

In other words, the difference between the participant's age, gender, family size, mother's educational attainment, parents' occupations, family income, and gain score and the expected association is not large enough to be statistically significant.

The null assumption cannot be rejected, but the non-significance result cannot indicate that H_0 is accurate.

The p-value, H_0 , on the other hand, is rejected. The correlation between the sample's previous, current grade, and gain score is not equal to the expected correlation (0). In other words, the difference between the sample and predicted correlation is large enough to be statistically significant.

This implies that the Sci-Math Board Game is a useful teaching tool for learners to enhance their math skills.

Table 17: Correlation analysis of relationship between the gain score - profile of learners in Science VI

Variable	r - value	Interpretation
Age	-0.24	weak negative relationship
Sex	0.29	weak positive relationship
Family sizes	-0.28	weak negative relationship
Educational attainment of father	0.20	weak positive relationship
Educational attainment of mother	0.12	no or negligible relationship
Family income	0.36	moderate positive relationship
Occupation of Parents	-0.36	moderate negative relationship
Previous Grade	0.41	strong positive relationship
Present Grade	0.52	strong positive relationship

Table 17 that there was a strong positive correlation between the learner's previous grade, present grade, and gain score ($r = 0.41$, $r = 0.52$). a weak negative connection ($r = -0.28$) between age, participant's family size and gain score. The occupation of the learner's parents was found to have a moderate negative correlation with gain score ($r = -0.36$). The learner's household income and gain score had a moderate positive correlation ($r = 0.36$). The gender, educational attainment of learner's father and gain score was found weak positive correlation ($r = 0.20$, $r = 0.20$). There was no other significant correlation between learner's mother's educational achievement, and gain scores ($r = 0.19$, $r = 0.02$, $r = 0.14$).

H_0 cannot be rejected since the p-value is $>$. The sample population's correlation is assumed to be equal to the expected correlation (0).

In other words, the difference between the participant's age, gender, family size, father's and mother's educational attainment, parents' occupations, family income, and gain score and the expected association is not large enough to be statistically significant.

The null assumption cannot be rejected, but the non-significance result cannot indicate that H_0 is accurate.

The p-value, H_0 , on the other hand, is rejected. The correlation between the sample's previous, current grade, and gain score is not equal to the expected correlation (0). In other words, the difference between the sample and predicted correlation is large enough to be statistically significant.

This suggests that the Sci-Math Board Game can be used to help students improve their science skills.

4. CONCLUSION

From the explanation above, it is very appropriate with the result that in the teaching and learning process, using Sci-Math Board Game is effective, especially in teaching science and math. Board games allow for various interactions that result in players engaging in computational thinking, teamwork, and creativity. The Sci-Math Board Game is effective because the board itself is a representation that helps connect information. Based on research findings, learner's achievement in science and math is effective in the teaching learning process and were able to understand more their lessons and strengthen lessons retention.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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