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

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ABSTRACT

This study aimed to see how effective the Sci-Math Board Game is, at improving elementary learners' academic performance in Science and Mathematics. Twenty Grade VI pupils from Tuyangan Elementary School in Tuyangan, Kabugao, Apayao participated. At the start of the academic year 2021-2022, the researcher used quasi-experimental research to conduct this study. The researcher employed quasi-experimental research to conduct this study at the start of the school year 2021-2022. The results showed that utilizing the Sci-Math Board Game in teaching and learning processes is successful, especially when teaching science and math. While playing board games, players can engage in computational thinking, teamwork, and creativity. Furthermore, there was a significant change in the participants' Science and Mathematics performance before and after using the Sci-Math Board Game as an instructional tool.

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

1. INTRODUCTION

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

A board game is a thrilling race of players that uses chips that are moved to mark the movement of players, which is relative to the game rule [1]. In the traditional way of teaching, it is hard to gain the attention of today's learners. However, a board game can be a useful tool to motivate learners to acquire knowledge and demonstrate their skills through creativity, concentration, self-confidence, competitiveness, and yearning for improvement using exploratory and experiential learning [2][3]. Board games are crafted to incorporate either player's technique or fortune. This kind of game typically has objectives that players wish to attain [1]. Board games that are conceptualized to address the learning competencies of learners can be used as instructional materials [4]. Through learner's exposure to Sc-Math Board Game, they can acquire knowledge actively and productively. This board game was gauged to be innovative, effective and interactive alternatives to suffice the needs of learners as they return to school because it motivates learners, boost their learning, entertaining and promotes teamwork among players [7]. Sci-Math Board Game can be used by teachers to teach learning competencies and introduce new concepts [5]. Furthermore, Sci-Math board game help learners to build friendships, strong parent-child relationships social skills and development [8][9][10][11][12].

Moreover, using board games as a teaching tool encourages learners to engage in participating learning activities to, enhance their academic performance, and enjoy learning activities without feeling threatened. [13] The development of Sci-Math Board Game is

based on the Department of Education (DepEd) which endorsed the need for new instructional materials under the key elements of an Indigenous Peoples Education Curriculum, which recommends the use of the IPEd Framework. This framework states that “The Learning Resources—Instructional Materials and other learning resources which will be created and used in conjunction with the curricular interaction and teaching-learning process” and were supported by [14] the Enhanced Basic Education Act of 2013 under Curriculum Development, which specified 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 construction of instructional materials is guided through [15] the National Adoption and Implementation of the LRMDS Framework, which serves as the guideline instrument for the implementation and ongoing operation of LRMDS at all levels of DepEd.

In addition to this [16], DepEd supported the LRMDS as a system designed to support the increased distribution and access to learning, teaching, and professional development resources at all levels of DepEd.

As the COVID-19 pandemic affected our society because of health risks, the education sector was forced to interrupt classes to avoid the spread of the virus among learners. The pandemic has made distance learning inevitable not only in urban areas but also in rural areas of the country. Despite 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 have shifted from the face-to-face to the distance learning method of teaching. 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 COVID-19 pandemic, Tuyangan Elementary School opened in the school year 2021–2022 using a modular distance learning approach, which suits the geographical environment of the school. The modular approach allows students to learn in the privacy of their own homes; with limited contact with teachers and parents; and serves as their model.

When limited face-to-face is being implemented, learners come back to school with low academic performance, especially in Science and Mathematics, due to more than a year of remote learning where a teacher’s guidance is highly needed.

Returning to school, on the other hand, was projected to enhance the difficulties of studying mathematics and science, which were regarded to be challenging by many pupils. As a result, it became critical to develop instructional materials to bridge the gap between teaching and learning of mathematics and science in this constrained face-to-face setting. Based on the [14] Enhanced Basic Education Act of 2013, 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 will devolve to regional and division education units.

While acknowledging that the entire educational system is affected, specific focus has been paid in this study to mathematics and science. This is because, even before the COVID-19 outbreak, kids' performance in mathematics and science was exceedingly low, not only in the locality, but also in several sections of the country and around the world.

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 other teaching materials to help students learn the concepts and the know-how of mathematics and science during the limited face-to-face time.

Significance of the Study

Teachers and students suffer from the lack of tools to reinforce and maintain students' moods and interests in concentrating on the lessons they teach.

The purpose of this study is to present board games as effective educational materials to the following groups.

- **Curriculum Developer.** The study's findings give a foundation for pushing for the full use or inclusion of learning games as tools in curriculum development.
- **School Heads.** The results of this study may be used to create a mathematics and sciences curriculum that stakeholders can use.
- **Science and Math Supervisors.** The findings of this study may be used to improve teaching approaches and identify the issues that contribute to poor academic performance. They could be used to develop strategies and other measures for achieving high-quality education.
- **Elementary Math Teacher.** The findings of this study will give teachers a better grasp of how to teach mathematics concepts.
- **Elementary Science Teachers.** The research findings will give teachers a better grasp of how to teach the science concepts.
- **Learners.** They are the primary recipients in the utilization of the game which will assist them in gaining insight into the firsthand experience.
- **Researchers.** It will be a reference for them when they undertake their research along this line.

The problem of the Study

This study was guided by the following research questions:

1. What is the profile of the grade six learner in Tuyangan Elementary School as to the following variables:
    a. Age
    b. Sex
    c. Educational Attainment of Father /Mother
    d. Monthly Income of Parents
    e. Occupation of Parents
    f. Number in the Family Members
2. What is the previous performance of the learners in Science and Mathematics

3. What is the pretest and post-test performance of the?
4. Is there a significant difference between the pretest and post-test of the learners?
5. What is the gain score of the learners?
6. What is the latest performance of the learners in Science and Mathematics?
7. Is there a relationship between the gain score of the learner on the following:

    a. Profile, variable
    b. Performance of the learner in Science and Mathematics

Answering, these questions provided insights into what ought to be the improvement of the performance of learners in mathematics and science in times of the limited face-to-face and beyond.

Objectives of the Study

This study generally aimed to determine the effectiveness of the Sci-Math Board Game for elementary learners in terms of learners' academic performance in Science and Mathematics VI.

Specifically, this study sought to:

1. determine the profile of the grade six learners in Tuyangan Elementary School;
2. determine the previous level of performance of the learners in Science and Mathematics;
3. determine the performance of the learners before and after their exposure to Science-Math Board games?
4. find out if the use of Sci-Math Board Game significantly affects the pretest-post-test results;
5. determine the gain score of the learners;
6. determine the latest performance of learners in Science and Mathematics;
7. find out if the profile of learners mediates the relationship between the independent variables and the present Grade of the learners in Science and Mathematics.

Research Hypothesis

The study tested the following hypothesis:

1. There is no difference between the pretest and post-test of the learners in using the Sci-Math Board game.
2. There is no relationship between the performance of the learner on the following variables:
    a. Age
    b. Sex
    c. Educational Attainment of Father /Mother
    d. Monthly Income of Parents
    e. Occupation of Parents
    f. Number in the Family Members
    g. previous grade in math/science
    h. present grade in math/science

Scope and Delimitation of the Study

This study was conducted with 20 Grade VI learners from Tuyangan Elementary School in Tuyangan, Kabugao, Apayao. This was carried out during the school year 2021-2022. The study concentrated on the factors that influence students' performance in Mathematics and Science.

Although numerous factors may correlate with students' performance in mathematics and science, the researcher chose only 8 in this study because it is believed that these factors (i.e., age, gender, etc.) have a significant impact on the learners' development as well as the educational process.

Uniqueness is observed in every endeavor in order to allow for the freshness and originality of work, which is attributed to the complexity of a human being. From this standpoint, the researcher did not include the teacher factor, because the researcher's goal is a significant deviation from the effectiveness of the Sci-Math Board Game, and the manifestation of a correlation to the aforementioned predictors of learners' performance in mathematics and science.

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. A 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 post-test scores

In experimental research, there were two variables that had a correlation with 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
   The dependent variable was observed or measured to determine whether a change or variation the independent variable causes or affects 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 which results low academic performance.

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 to get the validity of the respondents.

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

I. Form 137-E

DepEd form 137-E was used to determine the learners' level of performance. This form was also known as the permanent record for elementary students. It comprises the following information: students' names, places of birth, parents/guardians, transferred in/out (school), the total number of years to finish the elementary course, the learner's general average in her/his grade level studies, and the school year he/she started. In this form, the learner's curriculum year, grades from the various subjects prescribed in each 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 are also included. It also mentioned the month, days of school, and the days that the student attended school in every curriculum year.

II. Researcher-made Questionnaires

Data on the demographic profile of the participants were collected using questionnaires created by the researchers. The grade in grade five mathematics and science of the participants were gathered from the form-137-E or the participants' permanent records of grades.

III. Sci-Math Board Game

The Sci-Math Board Game developed by the researcher was used and integrated into 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 in adobe photoshop. It was validated and tried out in 2015 by 15 grade six learners, three teachers, and one principal of Pudtol District who is an expert in math and science. The figures below show the developed board game and other materials needed in using it as 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 goal of the game is to be the first person to reach the final square on the board from the starting square (any other player)

3. How to start the game

   The game will start using a die. The highest number of dots 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 by 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). To enter the board, each succeeding player must likewise toss a 1 to 6. Dice must be rolled again to determine how many squares the player entering the board may move at first. Place the marker in the appropriate square. Each player is only allowed to roll the die once.

5. Continue Playing:

   Each player will have a turn. The individual with the highest number is the first to go. Following that is the second highest, and so on. However, 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 a 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 a 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

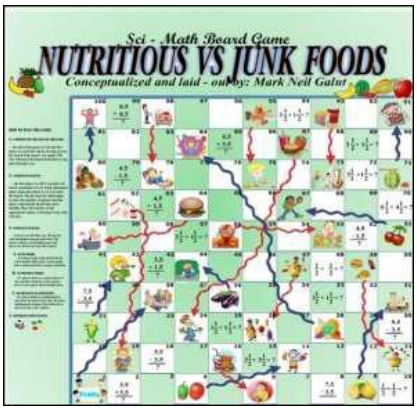

Figure 2 Sci-Math Board Game: Biodegradable vs non-biodegradable

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 a 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 decimals' 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 the community - about 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 - about 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 the 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 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 post-test 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 made a 40-item multiple choice test (20 in Mathematics and 20 in Science). Following the creation of a specification table, the test was carried out (TOS). A TOS is a test blueprint that shows how the teacher created exam questions. After the development of test questions, the researcher consulted with experts or teachers who teach the topics and read through the questionnaires. They assessed whether the questions adequately covered the areas under independent review. Just after the evaluation, the researcher confirmed the questionnaires with grade six students from neighboring schools. So after validation, the 40-item test questions were expanded to 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 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.

Scores from 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 utilized to determine the frequency counts and percentage distributions of the participants' personal profiles. As [21] Brown (2014) explains, percent, like fractions, is a technique to express components of a totality. In percent, however, one whole is always

considered to be 100 percent. According to [22] Young (2019), the frequency distribution is a representation of the number of surveys conducted during a certain time period. The frequency distribution is determined by the data being analyzed and the researcher's objectives.

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

Where:
P = Percentage
F = Frequency
N = Total Number of Respondents

For Pretest/Post-test Analysis

Mean. It was utilized to determine the participants' evaluations based on their pretest/post-test results. According to one study by [23] Martinez (2019), the mean is calculated by dividing the sum of all data entries by the number of entries. As explained by [14] Turner (2013), it is a measure of central tendency that is best suited for continuous data. The sum of a set of data points is divided by the total number of data points to calculate the mean.

Formula: $x = \sum x/n$
Where: x = mean
$\sum x$ = sum of all scores or values in distribution
N = total number of scores in the distribution

Standard Deviation. [25] Hargrave (2019) defines standard deviation as a figure that measures the distribution of data in relation to the mean. It is computed as the square root of the variance by determining the variance connecting each data point to the mean. This metric specifies how thoroughly the scores were clustered around the mean. According to [26] Bland (2006), the square root of the variance is known as the standard deviation, which is commonly symbolized by the letter s. SD is a common abbreviation. It is a gauge of how numbers will be distributed.

T-Test. It was originally known as the Student's T-test and was eventually shortened to the t-test. The T-test was performed to see whether the differences between the variables had a significant effect on each other. According to [27] Siegle (2019), the t-test is used to assess whether there is a significant difference in the means of two tests. A t-test is employed when the difference between the two tests averages is being studied. In other words, the t-test is employed when two means are being compared. The t-distribution is a type of probability distribution that is comparable to the normal distribution. It is often used to test numerical data assumptions, [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
Female	8	40

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
Below – 5,000	19	95

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
Total	**20**	**100**

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 members, 12 or 60% have 4-6, and 0 or 0% have 1-3. This means that most of the participants belong 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 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 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 pre-test, 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 ability 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 ability 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 a 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 in 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 a 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 the mathematics scores of learners. The findings of this study that the use of board games helps the learners concretize and understand abstract mathematical ideas which result in improved math scores are similar to [29] Sonnenschein et al. (2016). Based on 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 a directional t-test, and the computed value of t was 16.3. This value is more than the tabular value of t which is 1.3 at a 5 percent level of significance. This means that the null hypothesis is rejected, thus, there is

a significant difference between their scores before and after using the Sci-Math Board Game.

This is supported by [30] Bayeck's (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 a significant difference between the pretest and post-test scores of grade six learners using the Sci-Math Board Game
Statistical Inference		Significant			

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 in 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 a 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 the science scores of learners. The findings of this study that the use of board game helps the learners understand concepts in science which result in improved science scores are similar to [31] Fjællingsdal, K. S., & Klöckner, C. A. (2020). Based on 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 with 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 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 a directional t-test, and the computed value of t was 16.3. this value is more than the tabular value of t which is 1.2 at a 5 percent level of significance. This means that the null hypothesis is rejected, thus, there is a 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 interest in a board games. 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**	

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 games 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 show that generally, the participants have Very Satisfactory (85 – 89), in their second-quarter science. The mean of 83.75 implies a large improvement in the performance of learners.

Table 16: Correlation analysis of the 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 the gain score (r = 0.38). The learner's household income and the 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, and current grades, and the 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 the 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 the gain score (r = -0.36). The learner's household income and the gain score had a moderate positive correlation (r = 0.36). The gender, educational attainment of the learner's father and gain score were 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, and current grades, and the 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

According to the findings of the preceding study, using the Sci-Math Board Game in the teaching and learning process, particularly in the teaching of science and math, is very effective. Board games allow for a variety of interactions, resulting in computational thinking, teamwork, and creativity on the part of the participants. The Sci-Math Board Game works well because the board itself is a representation that aids in the connection of knowledge. According to research findings, student achievement in science and math is helpful in the teaching-learning process, and they were able to grasp more of their lessons and increase lesson recall.

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

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Consent

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

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