Central Mindanao University
Journal of Science
ISSN Print: 0116-7847 ISSN Online: 2704-3703

# Effects of Multiple Game-based Strategies in Grade 10 Science Learning

*Radzma A. Morales [1], Wilfred G. Alava, Jr. [2], and Alwielland Q. Bello [3]*

Esperanza City, Sultan Kudarat, 9806, Philippines
Natural Sciences Department, Bukidnon State University
Malaybalay City, Bukidnon, 8700, Philippines

## ABSTRACT

This study investigated the effects of multiple game-based strategies on learners' academic performance and engagement in Grade 10 Science. It was conducted at Esperanza National High School, Schools Division of Sultan Kudarat, during the school year 2019-2020. The study used one group pretest-posttest quasi-experimental research design. This was participated by Grade 10 learners. The development of lessons, validation of instruments, and try-out was made prior to the actual conduct of the study. The data gathered using the 30- item validated researcher-made academic performance test and engagement scale in Science were analyzed and interpreted using appropriate statistical techniques. Mean, standard deviation, and one-way analysis of covariance (ANCOVA) were also used. Findings revealed that the academic performance in Biology of Grade 10 learners taught with multiple game-based strategies was fairly satisfactory; while, the learners taught with the usual way of teaching method, "did not meet the expectation." There was a statistically significant difference in the academic performance between the learners' taught with multiple game-based strategies and those learners' who were taught with the usual way of teaching method. Moreover, the experimental group had high mean scores compared with that of the control group. The group of learners using multiple game-based strategies performed better.

*Keywords*: game-based strategies, instrument development, academic performance, ANCOVA

## INTRODUCTION

Game-based learning has the capacity to capture learners' attention and ensure their full involvement and engagement. The motivating process of games turns lessons dynamic and thought-provoking, whose appeal is maintained as learners' progress to achieve learning objectives (Plass et al., 2015).

Multiple game-based strategies refer to the use of games to improve learners' learning experience, while content and gaming are balanced, and its application is maintained in real-life situations. In the same way, the term gamification is the use of game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems (Kapp, 2012). Vlachopoulos & Makri (2017) indicated that games or simulations have a positive impact on learning goals. They studied the influence of games and simulations in achieving specific learning objectives and identified three learning outcomes when integrating games into the learning process: cognitive, behavioral, and affective.

The Department of Education's K-12 Program envisions refining the 21st-century skills of the learners, which has three main frameworks according to Scott (2017): (1) career and life skills, (2) learning skills and innovation skills, and (3) information, media, and technology skills. Hence, to motivate the learners to learn and appreciate Science as relevant and useful, educators must organize the curricula around situations and problems that challenge and arouse their curiosity (DepEd K-12 Science Curriculum Guide, 2016).

Biology is teeming with subject matter that obliges innovative and explorative style of pedagogical approach for better appreciation and understanding as an alternative to the usual classroom instruction using the traditional medium of packaged educational materials (Lao & Yuson, 2013).

Learners' learning engagement was increasingly observed as one of the keys to addressing difficulties such as low achievement, boredom, and alienation (Fredricks et al., 2004; Martin & Torres, 2017). Tyng et al. (2017) asserted that emotion has a substantial impact on attention, especially on modifying the selectivity of attention and motivating action and behavior. Emotion also facilitates encoding and helps the retrieval of information efficiently. This attentional and executive control is said to be intimately linked to learning processes.

One of the problems that Science teachers at Esperanza National High School are facing is enhancing the learners' academic performance. As observed in the result of their MPS (Mean Percentage Scores), the learners' academic performance in Science was low, especially the learners' under the Basic Education Curriculum. Another problem is the prominent use of gadgets by learners.

**Corresponding author:**
Alwielland Q. Bello
Email Address: a.bello@buksu.edu.ph
Received: Mar. 26, 2022 ; Accepted: Nov. 08, 2022

In this study, the researcher introduces a teaching strategy for Biology lessons, which integrates the merits of active learning through multiple game-based strategies. Learning through games lets the learners experiment in non-threatening situations and obtain knowledge through practice and social interaction both with their peers and their environment. Hence, it is essential to integrate multiple game-based strategies to enhance learners' engagement and improve their academic performance in Science.

**Framework of the Study**

Multiple game-based strategies were also anchored by the theory of active learning, by which postulates that learners take increasing responsibility for their knowledge. Rather than lecturers or deliverers of ideas, teachers are enablers and activators of learning. Active learning describes a classroom approach that acknowledges that learners are dynamic in the learning process, which contrasts with the model of instruction where knowledge is imparted or transmitted from the teacher to students (Bonwell & Eison, 1991).

Furthermore, multiple game-based strategies were also built upon the theory of cognitivism, which focused on knowledge transfer from instructors to students. Different aspects of interactivity in the classroom, including questioning and answering, informative feedback, and explanations, are effective ways to improve knowledge transfer. Through cognitivism, the learner became the center of attention where they acquire knowledge through varied modalities such as text, pictures, and sounds. Thus, it facilitates the learner to recognize and analyze problems and apply past learning (Protopsaltis, 2011).

The performance level in the pretest and posttest will be measured using the scale adapted from DepEd Order. No. 8 series of 2015: Outstanding, Very Satisfactory, Fairly Satisfactory, and Did Not Meet Expectations. The learner's level of engagement will be measured using an adapted and modified Attard's Learning Engagement Inventory Test (2012) in three categories: cognitive, behavioral, and affective.

Cognitive engagement includes investment, recognition of the value of learning, and willingness to go beyond the minimum requirements. Behavioral engagement comprises the awareness of active participation and connection in academic and social activities and is considered essential for achieving positive educational outcomes. Affective engagement covers students' reactions to school, teachers, peers, and academics, influencing their willingness to become involved in school activities (Attard, 2012).

Figure 1 presents the schematic diagram of the study and the visual representation of utilizing multiple game-based strategies. The boxes show the relationship between the variables in the study. The box on the left (Box A) shows the independent variable, which contains the two teaching strategies: teaching using multiple game-based strategies in the experimental group and using the usual teaching method in the control group. Both teaching strategies were used for the same topics for Grade 10 Learners in Biology. While the box on the right (Box B)

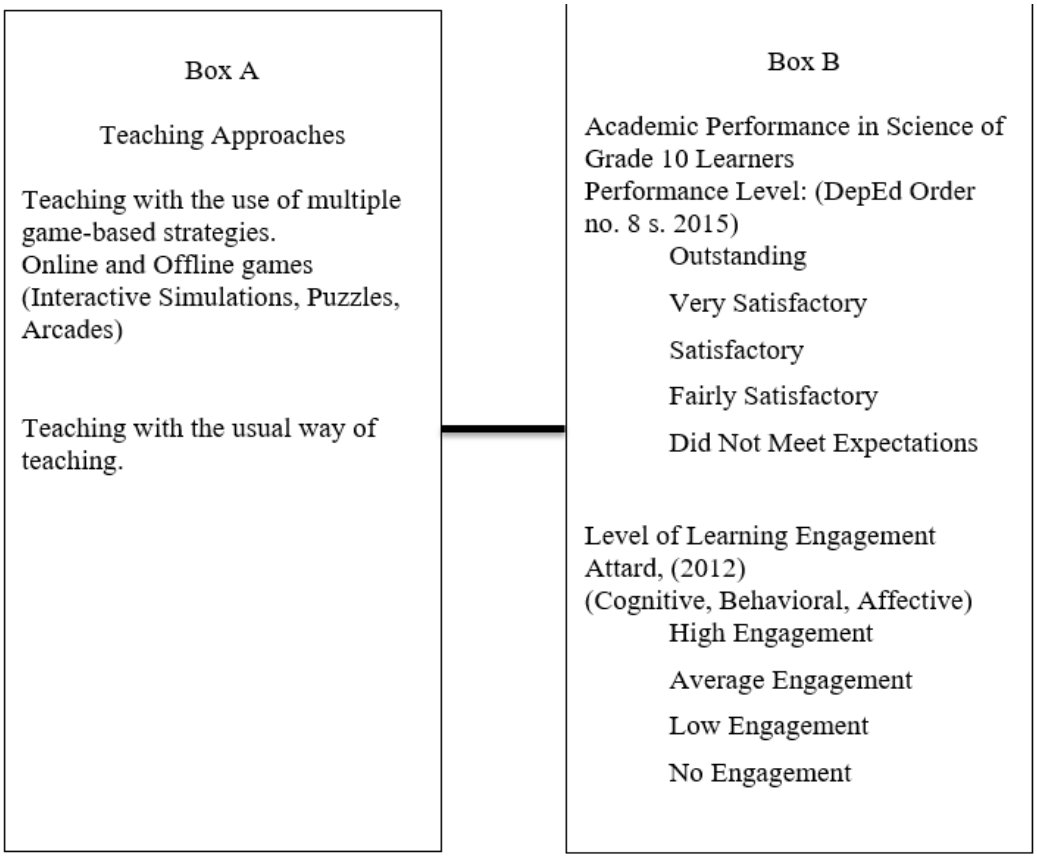


Figure 1: Schematic Diagram of the Study

shows the independent variables, which are the variables to be measured: academic performance and learners' engagement.

## STATEMENT OF THE PROBLEM

This study aimed to investigate the effects of the utilization of multiple game-based strategies on learners' academic performance and learning engagement. This study was conducted to selected Grade 10 learners of Esperanza National High School in the Division of Sultan Kudarat during the Third Quarter of the School Year 2019-2020.

Specifically, it sought answers to the following questions:
1. What is the academic performance of Grade 10 Learners in Science taught with the use of multiple game-based strategies and those that were taught using the usual teaching strategy?
2. What is the level of engagement of the learners taught with multiple game-based strategies in Science?
3. Is there a significant difference in the academic performance in Science between Grade 10 Learners taught using multiple game-based strategies, and those taught with the usual way of teaching?

Null Hypothesis
There is no significant difference in the academic performance and learning engagement of Grade 10 learners taught with the use of multiple game-based strategies, and those learners taught using the usual teaching strategy in Science.

### Significance of the Study

The researcher believes that the result of this study would benefit the following: the learners, science teachers, administrators, and other researchers.

The developed lessons in Science could serve as supplementary materials, which could further encourage them to create instructional materials on other topics. It could inspire them to be more innovative and explore more educational applications that would complement their lessons. It may support the teachers to modify their teaching strategies with the use of multiple game-based strategies.

### Delimitation of the Study

This study was limited to the use of multiple game-based strategies that serve as a tool for high school science teachers to improve learners' academic performance and increase learner involvement. The study was conducted during the third quarter of the school year 2019-2020 among the Grade 10 learners of Esperanza, National High School, Division of Sultan Kudarat.

The participants of this study were junior high school learners from the two selected Grade-10 classes from the Basic Education Curriculum (BEC). Thirty (30) learners from each section were assigned to the experimental group and the control group.

The research instrument in this study was a 30-item researcher-made academic performance test, the lesson plans, and a learning engagement scale questionnaire. The researcher used a quasi-experimental group comparison pretest-posttest research design to analyze the effect of the developed lessons using multiple game-based strategies on the learners' academic performance.

Definition of Terms

Multiple game-based strategies. Multiple game-based strategies are combinations of online and offline games that are used in the teaching and learning process. Game-based strategies include elements of competition, engagement, and immediate reward.

Academic Performance. Academic performance represents performance outcomes that specify the extent to which a learner has accomplished specific learning goals that were the emphasis of activities in instructional environments, specifically in school. It also refers to the mastery of a particular skill or behavior as measured through performance test scores. The performance level in the academic performance test scores will be scaled following the DepEd Order No. 8, series of 2015 as Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory, and Did Not Meet Expectation. In this study, the learners' level of academic performance is measured with the result of the pretest and posttest.

Level of Engagement. Learners' level of engagement refers to the amount of attention, curiosity, interest, optimism, and passion that the learners exhibit when being taught or when they are learning, which encompasses the level of motivation they have to learn and advance in their education (Abbott, 2014).

## METHODOLOGY

Research Design

This study tested the effectiveness of multiple game-based strategies in the class to the academic performance and engagement of the learners. The quasi-experimental pretest-posttest research design was utilized. This study used two (2) intact classes, Grade 10 learners from Esperanza National High School. Sixty (60) learners from the Basic Education Curriculum (BEC) Grade 10 learners were the participants in the study selected through random sampling.

In this design, the experimental group was taught using multiple game-based strategies, while the control group was taught the usual way of teaching using K-12 learning materials. Both experimental and control groups were given a pretest that will assess their previous knowledge of Biology concepts, specifically in DNA and RNA structure and central dogma. The answer of the learners was checked and recorded. The post-test scores of each group were compared and treated as the dependent variable of the study. The pretest and post-test exam results of the two groups were compared using One-way ANCOVA (Analysis of Covariance).

This instructional development model involves three stages: pre-development, development, and post-


Figure 2 Geographical Map of the Research Locale

development stage. These three stages permit the researcher to plan, develop, and revise the developed lesson based on insinuated experts. The first stage (pre-development) includes needs analysis, identifying objectives of the lesson, planning for the content, and TAM (Task Analysis Matrix) preparation. The researcher developed and prepared the Task Analysis Matrix as a guide for organizing the lesson. TAM aided the researcher in identifying the skills to be improved, instructional objectives to attain, and allocation of the number of days in covering the lessons.

Research Locale

The study was conducted at the Esperanza National High School, Division of Sultan Kudarat, Municipality of Esperanza, Province of Sultan Kudarat Region XII (SOCCSKSARGEN) during the school year 2019-2020. Esperanza National High School is situated in the southeastern part of Mindanao, specifically in the Province of Sultan Kudarat. It is located at Mabolo Street, Barangay Poblacion, Esperanza, near the municipality's public market.

Figure 2 shows the geographical map of the locale of the study, where the study was conducted. The map was obtained from the online google map showing a detailed view of the site (Map of Sultan Kudarat with Esperanza highlighted, 2018).

Participants of the Study

The participants of this study were two (2) intact classes of the Grade-10 level of Esperanza National High School in Esperanza's Municipality, Division of Sultan Kudarat. The participants are the selected Grade-10 learners out of fourteen (14) sections under the Basic Education Curriculum (BEC). The two intact classes involved in this study were made up of 48 learners in the experimental and 47 learners in the control group. The thirty learners from the control group are paired with the thirty learners in the experimental group based on their grades in Science from the second grading period.

Research Instrument

The 30-item validated researcher-made academic performance test was used in the paper-and-pencil test. The test was developed to measure and determine the academic performance of Grade 10 learners in the following Biology topics: DNA and RNA structure, Central dogma (Replication, Transcription, and Translation) Gene Mutations. The included topics in the academic performance test were based on the learning competencies from the third quarter K-12 learners' module in Science. The construction of the test was guided by a Table of Specification (TOS).

The researcher-made test was validated by three (3) panels of experts. Initially, the test consists of 50-item questions based on the competencies enumerated in the (TOS).

After the revision of the material, the test was tried out on Grade -11 learners from Bukidnon Laboratory School. The test results were used to test the internal consistency of the survey questionnaire. The result was analyzed and interpreted with the help of a statistician. The computed Cronbach alpha ($\alpha$) = 0.801 indicated a highly acceptable performance test.

To measure the engagement level of the learners,

the researcher adapted and modified the learning engagement scale by Attard (2012). It was content validated by the three (3) panels of experts. The three evaluators agreed on the content accuracy of the items and strongly agreed on the clarity and appropriateness of the items in the learning engagement questionnaire.

Scoring Procedure for the Academic Performance Test

In the Academic Performance test, 30 points are the perfect score. A scoring scale for the academic performance was set based on DepEd Order #8 s. 2015 to assign the corresponding academic performance of the students from their scores on the test.

Engagement of the Learners

The researcher adopted and modified the Learning Engagement Scale of Attard (2012). The learners' engagement level was categorized into three: cognitive, behavioral, and affective. This scale was used to measure and evaluate the learners' opinions, actions, and participation in Science.

Data Gathering Procedure

The data gathering was held at Esperanza National High School, Esperanza, Sultan Kudarat, in the third quarter of the school year 2019-2020. The researcher explained the rationale and processes involved in the study to orient the participants concerned and obtain the data needed for the fulfillment of the study. Permission from the school principal was asked and secured in writing prior to the conduct of the study.

Treatment of the Data

After the gathering of the necessary data, it was treated with appropriate statistical tools.
For both problems 1 and 2, the mean and standard deviation were used to treat the data to assess the academic performance in Science of Grade-10 learners taught with multiple game-based strategies and those who were taught with the usual way of teaching. Mobile applications (apps) were used in this study as learning and teaching tools which are not uncommon even in Higher Education (Pechenkina, 2017).

For problem 3, One-way Analysis of Covariance (ANCOVA) at 0.05 level of significance was used to compare the academic performance in Science of Grade-10 learners taught with multiple game-based strategies and those who were taught with the usual way of teaching.

## RESULTS AND DISCUSSION

Academic Performance of the Control Group and Experimental Group

To determine the learners' academic performance in the control and experimental group, means and standard deviations of the pretest and posttest were compared and analyzed. The academic performance was measured following the DepEd order no. 8, s. 2015 and categorized as Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory, and Did Not Meet Expectations.
Table 1 presents the means and standard deviations of the pretest and posttest of Grade 10 learners taught with multiple game-based strategies, and those learners taught

| Score Range | Equivalent Numerical Value | Level of proficiency | Qualifying Statements |
|---|---|---|---|
| 28-30 | 90% and above | Outstanding | Exceeds the core requirements in terms of knowledge, skills and understanding in Science and can transfer them automatically and flexibly through authentic task |
| 25-27 | 85%-89% | Very Satisfactory | Develop the fundamental knowledge, skills and understanding in Science and can transfer them automatically and flexibly trough authentic task. |
| 22-24 | 80%-84% | Satisfactory | Develop the fundamental knowledge, skills and understanding in Science with little guidance from the teacher and or with some assistance from peers, can transfer these understanding through authentic performance task. |
| 19-21 | 75%-79% | Fairly Satisfactory | Possess the minimum knowledge, skills and core understanding in Science but needs help throughout the performance of authentic task |
| 0-18 | 74% and below | Did not Meet expectation | Struggles with understanding; prerequisite and fundamental knowledge and or skills in Science have not been acquired or developed adequately to aid understanding. |

| Scale | Range | Response | Qualifying Statement |
|---|---|---|---|
| 4 | 3.25 - 4.00 | Always | Learners have high engagement in Science |
| 3 | 2.50 - 3.24 | Usually | Learners have an average engagement in Science |
| 2 | 1.75 - 2.49 | Sometimes | Learners have low engagement in Science |
| 1 | 1.00 - 1.74 | Never | Learners have no engagement in Science |

Table 1. Pretest and Posttest of the Learners Academic Performance in Science

| Groups | | Pretest | | | Posttest | | |
|---|---|---|---|---|---|---|---|
| | N | *x* | SD | Performance Level | *x* | 3.451 | Performance Level |
| Control | 30 | 12.433 | 3.626 | Did not meet expectations | 17.867 | 3.451 | Did not Meet expectations |
| Experimental | 30 | 13.167 | 2.506 | Did not Meet expectations | 20.167 | 2.829 | Fairly Satisfactory |

using the usual teaching method.

Table 1 shows both pretest and posttest of the control and experimental group in Science, particularly topics in Biology, central dogma: replication, transcription, translation, and mutations. The control and experimental groups were in Did Not Meet Expectations level, based on the academic descriptions set by the Department of Education.

Pretest mean scores for both the control and experimental group showed that the learners' struggles with understanding the selected topics in Science. The pretest mean scores also indicate that the prerequisite and fundamental knowledge and or skills in Science have not been acquired or developed adequately to aid understanding.

Rogayan Jr. (2019) gauged the effect of the Biology Learning Station Strategy (BLISS) on junior high school student's academic achievement and attitude in Central Luzon. Similar to the present study, this action research utilized a within-group pretest-posttest experimental design involving 28 Grade 10 Science students. The results show that learners' Science achievement and their attitude towards learning Biology had improved. The researcher also found that there was a positive relationship between learners' achievement and attitude toward Biology.

Engagement in Science of Grade 10 Learners

This study examined the engagement of learners in Science when taught using Multiple Game-Based Strategies and when taught using the usual teaching strategies. To determine the engagement of the learners in Science, both the experimental and control groups, pretest and posttest mean, and standard deviations of the engagement scale were obtained, analyzed, and compared.

Table 2 presents the overall engagement in Science of Grade 10 Learners in the two groups before and after the conduct of the study. Results indicate that before the conduct of the study, the control group and experimental groups had an average engagement in Science based on the mean of the pretest scale. The standard deviation in the pretest in both groups show that the answers of the learners from the experimental group were more dispersed compared with the control group.

The posttest mean results revealed that after the conduct of the study, the engagement of both groups was still on the average engagement level. However, the posttests mean of learners' responses was high in the experimental group compared to the control group. It could be inferred that with the use of multiple game-based strategies, there is an increase in the learners' engagement in Science better than the increase made in the control group.

The result of the study supports the findings of Liu and Chen (2013) that using games could increase students' motivation and interest to learn in a regular class. Nahmod (2017) emphasized that the use of technology in the classroom makes learning more easily accessible, creative, and fun. Zarzycka-Piskorz (2016) postulated that when learning incorporates any form of gamification, the learning process becomes more engaging as intrinsic motivation is induced.

Jones et al. (2015) conducted a study to contribute to the current theories of gamification and its ability to assist with the learning experience. Results indicate that the game was an excellent way to engage people with physics. The findings indicate that gamification is a valuable educational tool. The study conducted by Pesare et al. (2016) also supports the present study that games enhance student motivation, which means improvement and knowledge acquisition of the participants. Smart Learning Environment was utilized in this study.

The posttest mean results revealed that after the conduct of the study, the engagement of both groups was still on the average engagement level. However, the posttests mean of learners' responses was high in the experimental group compared to the control group. It could be inferred that with the use of multiple game-based strategies, there is an increase in the learners' engagement in Science better than the increase made in the control group.

The result of the study supports the findings of Liu and Chen (2013) that using games could increase students' motivation and interest to learn in a regular class. Nahmod (2017) emphasized that the use of technology

Table 2. Learners Over-all Engagement in Science

| Engagement | Control Group | | | | | | Experimental Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pretest | | | Posttest | | | Pretest | | | Posttest | | |
| | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD |
| Cognitive | 2.37 | .056 | S | 2.46 | 0.38 | S | 2.51 | 0.33 | U | 2.92 | 0.17 | U |
| Behavioral | 2.88 | 0.33 | U | 2.88 | 0.33 | U | 2.75 | 0.34 | U | 3.05 | 0.19 | U |
| Affective | 2.93 | 0.47 | U | 3.02 | 0.46 | U | 2.79 | 0.30 | U | 3.21 | 0.27 | U |
| Overall Engagement | 2.73 | 0.28 | S | 2.79 | 0.39 | U | 2.68 | 0.32 | U | 3.06 | 0.21 | U |

Table 3. Pretest and Posttest Scores of Cognitive Engagement of Learners

| Items | Control Group | | | | | | Experimental Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pretest | | | Posttest | | | Pretest | | | Posttest | | |
| | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD |
| 1. I am looking forward to learn more in Science. | 2.37 | 0.56 | S | 2.87 | 0.78 | U | 2.73 | 0.69 | U | 3.00 | 0.53 | U |
| 2. I read my Science book in advance to be ready in our class. | 2.07 | 0.64 | S | 2.17 | 0.46 | S | 2.13 | 0.68 | S | 2.80 | 0.67 | S |
| 3. I devote my time to practice solving Science problems after school. | 1.87 | 0.68 | S | 2.03 | 0.56 | S | 2.20 | 0.55 | S | 2.70 | 0.70 | U |
| 4. I am thinking a lot in Science class | 2.33 | 0.76 | S | 2.33 | 0.61 | S | 2.50 | 0.51 | U | 2.90 | 0.61 | U |
| 5. In my free time, I spend time to look for more information on topics discussed in Science class. | 1.93 | 0.58 | S | 2.00 | 0.53 | S | 2.30 | 0.75 | S | 2.77 | 0.68 | U |
| 6. Whenever I am absent in class, I am asking my classmates to help me understand my missed Science lesson. | 2.23 | 1.01 | S | 2.70 | 0.88 | U | 2.77 | 0.97 | U | 3.10 | 0.71 | U |
| 7. I recognize the value of learning in our Science class. | 2.40 | 0.56 | S | 2.87 | 0.68 | U | 2.77 | 0.73 | U | 3.00 | 0.64 | U |
| 8. I am investing time and efforts to learn a lot in our Science lessons. | 2.37 | 0.62 | S | 2.67 | 0.55 | U | 2.63 | 0.72 | U | 2.80 | 0.61 | U |
| 9. I have to stay late at night to study our lessons in Science. | 1.93 | 0.69 | U | 2.0 | 0.41 | S | 2.03 | 0.72 | S | 2.87 | 0.73 | U |
| 10. I am trying to learn as much as I could in our Science class. | 2.53 | 0.73 | S | 2.90 | 0.76 | U | 3.03 | 0.77 | U | 3.32 | 0.68 | U |
| Subtotal | 2.37 | .056 | S | 2.46 | 0.38 | S | 2.51 | 0.33 | U | 2.92 | 0.17 | U |

Legend: A= Always, U= Usually, S= Sometimes, N= Never

in the classroom makes learning more easily accessible, creative, and fun. Zarzycka-Piskorz (2016) postulated that when learning incorporates any form of gamification, the learning process becomes more engaging as intrinsic motivation is induced.

Jones et al. (2015) conducted a study to contribute to the current theories of gamification and its ability to assist with the learning experience. Results indicate that the game was an excellent way to engage people with physics. The findings indicate that gamification is a valuable educational tool. The study conducted by Pesare et al. (2016) also supports the present study that games enhance student motivation, which means improvement and knowledge acquisition of the participants. Smart Learning Environment was utilized in this study.

Table 3 presents the learners' cognitive engagement in Biology between the control and experimental groups. Pretest responses indicate that the control group had low

cognitive engagement while the experimental group had an average engagement in Science before the conduct of the study.

In the cognitive dimension, more significant improvements were contributed by the use of multiple game-based strategies as compared to the use of the usual way of teaching. The relevant improvements were attributed to the teaching strategies employed. The utilization of online and offline games and downloadable mobile applications gave more notable results than the regular traditional lecture-based strategy.

Table 4 shows the behavioral engagement in the Science of the learners. The pretest and posttest mean responses of the experimental and the control groups were presented. Results revealed that before the conduct of the study, both groups had an average behavioral engagement. After the conduct of the study, the two groups remain at the average behavioral engagement level. However, the use of multiple game-based strategies had a higher increase compared to the use of the usual way of teaching. The standard deviations in the pretest and posttest of the control group have very minimal changes.

Table 5 presents the affective engagement in the Science of the learners in the control and experimental groups. Both group's pretest and posttest results were on the average affective engagement level. The control group's responses were more widely dispersed compared to that of the experimental group. In the level of enjoyment in the activities in the class in item number nine (9), the experimental group posttest shows that the learners enjoyed the activities with the use of multiple game-based strategies. Moreover, the use of the said strategy had helped the learners to improve their affective engagement in Biology. The level was in average, but with the proper implementation, it would reach the highest level of affective engagement.

The results support the previous research conducted by Von Gillern & Alaswad (2016) that examines digital and non-digital games as useful mechanisms for promoting student engagement and learning. They argue that games can stimulate motivation, engagement, and learning.

Table 4. Pretest and Posttest Scores of Behavioral Engagement of Learners

| Items | Control Group | | | | | | Experimental Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pretest | | | Posttest | | | Pretest | | | Posttest | | |
| | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD |
| 1. I am listening to the teacher's discussion during Science class. | 3.23 | 0.77 | U | 3.33 | 0.71 | A | 3.47 | 0.63 | A | 3.37 | 0.56 | A |
| 2. I am doing the seat-works given by the Science teachers in class. | 3.27 | 0.87 | A | 3.10 | 0.89 | U | 3.00 | 0.70 | U | 3.20 | 0.66 | U |
| 3. I am standing and answering my teacher's questions when called in Science class. | 2.57 | 0.94 | U | 2.50 | 0.90 | U | 2.57 | 0.57 | U | 2.83 | 0.65 | U |
| 4. I am raising my hands whenever I know the answer. | 2.70 | 0.88 | U | 2.80 | 0.89 | U | 2.67 | 0.84 | U | 3.10 | 0.66 | U |
| 5. I am doing my assignment in Science. | 3.27 | 0.87 | A | 3.33 | 0.76 | A | 2.77 | 0.63 | U | 3.17 | 0.70 | U |
| 6. I am raising my hands and ask questions whenever I have queries about the lesson presented in our Science class. | 2.30 | 0.60 | S | 2.30 | 0.65 | S | 2.17 | 0.70 | S | 2.83 | 0.54 | U |
| 7. I am actively participating in the different activities in our Science class. | 2.60 | 0.68 | U | 2.90 | 0.80 | U | 2.57 | 0.77 | U | 2.87 | 0.63 | U |
| 8. I am studying my lesson at home whenever there are tests in Science. | 2.87 | 0.90 | U | 2.80 | 0.76 | U | 2.63 | 0.62 | U | 2.90 | 0.71 | U |
| 9. I am writing down notes in my Science class. | 3.03 | 0.85 | U | 2.90 | 0.92 | U | 2.80 | 0.89 | U | 3.03 | 0.72 | U |
| 10. I am doing my Science projects creatively and submit it on time. | 2.97 | 0.77 | U | 2.87 | 0.82 | U | 2.83 | 0.79 | U | 3.23 | 0.73 | U |
| Subtotal | 2.88 | 0.33 | U | 2.88 | 0.33 | U | 2.75 | 0.34 | U | 3.05 | 0.19 | U |
| Legend: A= Always, U= Usually, S= Sometimes, N= Never | | | | | | | | | | | | |

Table 5. Pretest and Posttest Scores of Affective Engagement of Learners

| Items | Control Group | | | | | | Experimental Group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pretest | | | Posttest | | | Pretest | | | Posttest | | |
| | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD | *X* | SD | QD |
| 1. I like the feeling when I am solving problem. | 2.33 | 0.66 | S | 2.50 | 0.73 | U | 2.53 | 0.63 | U | 3.03 | 0.56 | U |
| 2. I am helping my classmates in solving problems whenever they have difficulties | 2.20 | 0.71 | S | 2.23 | 0.43 | S | 2.23 | 0.68 | S | 2.87 | 0.68 | U |
| 3. I am sharing my ideas and notes to my classmates in Science. | 2.47 | 0.78 | S | 2.70 | 0.75 | U | 2.53 | 0.68 | U | 2.93 | 0.79 | U |
| 4. I am trying my best not to be absent in Science class | 3.40 | 0.77 | A | 3.40 | 0.77 | A | 2.80 | 0.66 | U | 3.47 | 0.63 | A |
| 5. I am happy that my teacher in Science encourages me to be involved in class | 3.33 | 0.84 | A | 3.40 | 0.86 | A | 3.10 | 0.55 | U | 3.30 | 0.54 | A |
| 6. I am glad that my classmates are willing to help me in answering Science problem. | 3.07 | 0.83 | U | 3.17 | 0.75 | U | 2.80 | 0.61 | U | 3.00 | 0.74 | U |
| 7. I like the way my Science teacher delivers the lesson in class. | 3.23 | 0.90 | U | 3.40 | 0.81 | A | 3.13 | 0.57 | U | 3.53 | 0.51 | A |
| 8. My Science teacher tries her best for me to learn. | 3.50 | 0.78 | A | 3.57 | 0.73 | A | 3.13 | 0.51 | U | 3.63 | 0.49 | A |
| 9. I enjoyed the activities in our class. | 3.03 | 0.96 | U | 3.17 | 0.75 | U | 2.93 | 0.69 | U | 3.30 | 0.54 | A |
| 10. I am not bored in our Science class. | 2.70 | 0.99 | U | 2.67 | 0.80 | U | 2.67 | 0.61 | U | 3.03 | 0.81 | U |
| Subtotal | 2.93 | 0.47 | U | 3.02 | 0.46 | U | 2.79 | 0.30 | U | 3.21 | 0.27 | U |

Legend: A= Always, U= Usually, S= Sometimes, N= Never

Test of Significant Difference in the Academic performance Between the Experimental and Control Group.

The study examined the engagement of learners in Science when taught using multiple game-based strategies and when taught using the usual way of teaching. To determine the learners' engagement in Science of the control and experimental groups the pretest and posttest mean, and standard deviations of the engagement scale were obtained, compared, and analyzed.

The results show that there is a statistically significant difference in academic achievement between the control group and the experimental group in favor of the experimental group. The difference must have resulted from the use of multiple game-based strategies.

The study of Francisco-Catle (2018) pointed out the positive effects of computer-based educational games on students' achievement in science. Thus, the researcher investigated the effects of computer-based games in gauging learners in science. The study resulted that there is a significant difference in the learners' achievement in Science after the treatment. The researcher recommends integrating technology in the form of computer-based educational games in teaching Science. It was also suggested to utilize other computer-based online games on other platforms such as mobile phones.

## CONCLUSION

Based on the findings of the study, the following conclusions were formulated:

There was a significant difference between the academic performance pretest and posttest; therefore, the use of multiple game-based strategies in teaching improves the performance of learners on their Science subject. The use of multiple game-based strategies has enhanced the learners' engagement, especially the learners' cognitive engagement, to learn more about the subject. There is a significant relationship between the academic performance of the learners between the control and the experimental group; therefore, the use of multiple game-based strategies can enhance the learners' academic performance.

## RECOMMENDATION

Based on the findings, the following are

Table 6. One - Way ANCOVA to compare the Learners Academic Performance between the Control Group and the Experimental Group

| Source of variation | Sum of Squares | DF | Mean Square | F-ratio | p-value |
|---|---|---|---|---|---|
| Covariates | 201.41 | 1 | 201.411 | 30.50 | 0.000 |
| Main Effects | 51.25 | 1 | 51.249 | 7.76 | 0.007 |
| Error | 376.22 | 57 | 6.600 | | |
| Lack-of-Fit | 147.89 | 20 | 7.394 | 1.20 | 0.309 |
| Pure Error | 228.33 | 37 | 6.171 | | |
| Total | 656.98 | 59 | | | |

recommended:

The lessons used in this study may also be replicated to other schools, districts, or divisions since it improves the learners' engagement and academic performance. Science teachers may use instructional strategies utilizing multiple game-based strategies. Given the results, the lowest items in the cognitive, behavioral, and affective engagement scale and academic performance test may be improved and recommended to give more emphasis on further research. Teachers may consider the use of multiple game-based strategies for remediation.

## REFERENCES


Abbott, S. (2014). Hidden curriculum. The glossary of education reform.

Attard, C. (2012). Engagement with Mathematics: What Does It Mean and What Does It Look Like? Australian Primary Mathematics Classroom, 17(1), 9-13.

Bonwell, C. C., & Eison, J. A. (1991). Active Learning: Creating Excitement in the Classroom. 1991 ASHE-ERIC Higher Education Reports. ERIC Clearinghouse on Higher Education, The George Washington University, One Dupont Circle, Suite 630, Washington, DC 20036-1183.

Department of Education. (2016). K to 12 Curriculum Guide (Science). DepEd Order No. 8, s. 2015 (Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program).

Francisco-Catle, A. D. (2018) Effects of Computer-Based Educational Games on Students' Achievement in Science.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. Review of educational research, 74(1), 59-109.

Jones, J., Caton, H., & Greenhill, D. (2015). Using game-based learning to engage people with Physics: how successful could 'Junkyard Physics' be. The Higher Education Academy.

Kapp, K. M. (2012). The gamification of learning and instruction: game-based methods and strategies for training and education. John Wiley & Sons.

Lao, D. M., & Yuson, B. K. M. (2013). Web-based Interactive Learning and Teaching of the Human Immune Response to Pathogenic Activity. LCCB Development Education Journal of Multidisciplinary Research, 2(1), 1-1.

Liu, E. Z. F., & Chen, P. K. (2013). The effect of game-based learning on students' learning performance in science learning–A case of "conveyance go". Procedia-Social and Behavioral Sciences, 103(26), 1044-1051.

Map of Sultan Kudarat with Esperanza highlighted (2018). Retrieved from https://en.wikipedia.org/wiki/Esperanza,_Sultan_Kudarat#/media/File:Ph_locator_sultan_kudarat_esperanza.png on March 2, 2018.

Martin, J., & Torres, A. (2017). User's guide and toolkit for the surveys of student engagement: The high school survey of student engagement (HSSSE) and the middle grades survey of student engagement (MGSSE). National Association of Independent Schools.

Nahmod, D., M. (2017). Vocabulary gamification vs traditional learning instruction in an inclusive high school classroom.

Pechenkina E. (2017). Developing a typology of mobile apps in higher education: A national case-study. Australasian Journal of Educational Technology, 33(4), 134–146. https://doi.org/10.14742/ajet.3228.

Pesare, E., Roselli, T., Corriero, N., & Rossano, V. (2016). Game-based learning and gamification to promote engagement and motivation in medical learning contexts. Smart Learning Environments, 3(1), 5. DOI: https://doi. org/10.1186/s40561-016-0028-0.

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game- based learning. Educational Psychologist, 50(4), 258-283.

Protopsaltis, A. (2011). Learning theories and serious games. Serious Games Institute.

Rogayan Jr, D. V. (2019). Biology Learning Station Strategy (BLISS): Its effects on science achievement and attitude towards biology. International Journal on Social and Education Sciences, 1(2), 78-89.

Scott, L. A. (2017). 21st century skills early learning framework. Partnership for 21st Century Skill (P21). Retrieved from http://www.p21.org/storage/

documents/EarlyLearning_Framewor k/ P21_ELF_ Framework_Final.pdf.

Tyng, C. M., Amin, H. U., Saad, M., & Malik, A. S. (2017). The Influences of Emotion on Learning and Memory. Frontiers in psychology, 8, 1454. https://doi.org/10.3389/fpsyg.2017.01454

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. International Journal of Educational Technology in Higher Education, 14(1), 22. DOI 10.1186/s41239-017-0062-1

Von Gillern, S., & Alaswad, Z. (2016). Games and Game-Based Learning in Instructional Design. International Journal of Technologies in Learning, 23(4), 1-7.

Zarzycka-Piskorz, E. (2016). Kahoot it or not? Can games be motivating in learning grammar? Teaching English with Technology, 16(3), 17-36.