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GAME-BASED AND CONVENTIONAL LEARNING: THEIR EFFECTS ON LEARNERS' COMPREHENSION OF SCIENTIFIC CONCEPTS IN EARTH SCIENCE

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ABSTRACT

This quasi-experimental study was conducted to determine the effects of game-based learning and conventional learning on the comprehension of scientific concepts among seventy (70) Grade 11 STEM learners from two intact classes at Dumangas National High School during the 2024-2025 school year. The results revealed that learners' scores improved significantly in the posttest compared to the pretest when using game-based learning, indicating enhanced comprehension of scientific concepts. A significant difference existed between the pretest and posttest results of learners using game-based learning. No significant difference was found between the pretest and posttest results of learners using conventional learning. Significant differences existed between game-based learning and conventional learning in both pretest and posttest results. These findings suggested that game-based learning is more effective than conventional learning in improving learners' comprehension of scientific concepts.

Keywords: *Game-Based learning, Conventional learning, Scientific concepts*

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INTRODUCTION

A nation's progress has long been inextricably linked to the strength of its educational system, a vital component of civilization since its earliest stages. Historically, rote learning and standardized testing were the primary goals of instruction, shaping the methods employed by educators. Maintaining order and discipline was paramount in traditional classrooms, with instructors holding significant authority over the learning process. Contemporary society, characterized by rapid technological advancements, has fostered a more dynamic and inquisitive intellectual climate. Modern students seek learning experiences that extend beyond textbooks, embracing innovative and engaging methods. Contemporary educational practices employ diverse methods to enhance teaching effectiveness and improve student outcomes; modern pedagogy emphasizes holistic development, nurturing both the skills and values of the student. Modern learning environments prioritize student engagement, utilizing technology to support a more collaborative and less formal atmosphere (Wang, 2022).

The integration of game mechanics into education is not a recent innovation, but its adoption has significantly increased recently, driven by a desire for more interactive learning experiences. Over the past three decades, advancements in technology have fueled the growth and widespread use of game-based learning strategies (Serrano, K., 2020). This approach offers a highly effective way to improve learning and building effective 21st-century educational settings. Game-based learning adapts elements of game design to create more engaging real-world learning experiences (Remo, A. A., & Velasco, C. 2023). The inherent motivational aspects of games make learning more dynamic and enjoyable for students; it's

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not simply about entertainment; it involves carefully structuring learning activities to progressively build understanding and achieve specific learning objectives. Games often utilize competition, rewards, and feedback mechanisms to enhance engagement; these techniques are gaining traction in higher education and library settings as tools to promote student engagement.

This study aimed to investigate the effects of game-based learning (GBL) and conventional learning on Grade 11 STEM learners' comprehension of scientific concepts in Earth Science. The researcher hypothesized that GBL can enhance learners' understanding of scientific concepts, promote overall development, and improve academic performance in science and other subjects. Specifically, GBL is expected to improve skills in data analysis, decision-making, and problem-solving. To explore the efficacy of GBL, this study compared its effects with those of conventional learning on learners' comprehension of scientific concepts.

MATERIALS AND METHODS

Research Methodology

This chapter presents the research method, research design, respondents of the study, research instrument, data gathering procedures, data analyses, and statistical tools used.

Research Method

This study utilized an experimental research design, a scientific method for investigating cause-and-effect relationships between variables (Em, 2024). This involved manipulating one or more independent variables to observe their effects on a dependent

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variable, while controlling for extraneous variables that might otherwise affect the results. The data gathered helped the researcher to find out the effects of game-based learning and conventional learning on the comprehension of scientific concepts of Grade 11 STEM students.

Research Design

The study used quasi-experimental research design. Quasi-experimental research determines the relationship between two (2) variables-the dependent variable and the independent variable. This type of design requires two sample classes, namely the experimental and control classes. The experimental class is the class that will be given treatment, and the control class is the class that is not given treatment - usually using direct learning, which is often known as the conventional approach (Isnawan, 2022). Following an experimental study, the observed relationship between a characteristic of the subject and the variable under investigation is either confirmed or refuted.

Pretest was conducted at the beginning of the experiment and posttest was given at the end of the experiment. The pretest assessed the extent to which the two groups are similar. The results of the posttest determined the effectiveness of the intervention which the experimental group was exposed to. This method of research is considered to be the best fitted in this research activity since the study was conducted to determine the effects of game-based learning and conventional learning on comprehension of scientific concepts of Grade 11 STEM learners of Dumangas National High School, Ilaya 1st, Dumangas, Iloilo for the first quarter of school year 2024-2025.

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The independent variables were the game-based learning and conventional learning, while the dependent variable was the scientific concepts of Grade 11 STEM learners.

Subjects of the Study

The study's participants consisted of seventy (70) Grade 11 STEM learners from Dumangas National High School, Ilaya 1st, Dumangas, Iloilo during the school year 2024-2025. Two sections were purposively selected for the study due to their similar academic performance, as determined by matching their science final grades in Grade 10. These sections were then assigned to either the experimental group or the control group, with each group receiving a distinct intervention.

The data is shown in Table 1.

Table 1

Distribution of the Participants

Section	N
11-XENON	35
11-RADON	35
Total	70

The subjects received pretest and posttest before and after the experiment, respectively.

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Research Instrument

Pretest and Posttest

Table of Specifications (TOS) was made prior to the construction of the test to proportionate the number of items to the topics. In doing so, the researcher considered content of the grading, objective or learning competencies, time allotment for each objective, expected number of test items to be constructed and item placement.

The researcher-made questionnaire was used to determine the background knowledge of the learners. This was conducted prior to the experiment. The same researcher-made questionnaire was used for the posttest to determine the effects on the comprehension of scientific concepts of students after exposure to game-based learning and conventional learning. In making the questionnaire the researcher used the learners' module, and other science textbook and references. Questions were categorized according to the skills in data collection, data analysis, problem solving, interpretation of data, and integrating data.

The test was composed of 30 items, the research instrument includes the following topics: Earth's Characteristics, Earth's Subsystem, Physical and Chemical Properties of Rocks, Types of rocks, Importance of Minerals to Society, Ores, and Fossil Fuels which were based on the Department of Education K to 12 science curriculum guide and was presented to the jury of experts in science and test construction. The validated test was subjected to pilot testing using reliability test.

The researcher made a matrix of activities of game-based learning and conventional learning in teaching scientific concepts that followed during the duration of the research with

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the following data: topics, time allotment, date intended for the topic, and the methods to be used.

The initial draft of the test was submitted for face and content validation to a jury of experts in science and test construction. The expert's comments and suggestions were presented to the thesis adviser before the instrument was finalized.

Lesson Plan

In making the lesson plans, the researcher adopted the 7 E's method: elicit, engage, explain, explore, elaborate, evaluate and extend. Lesson plans were based on the Department of Education K to 12 science curriculum guides. Worksheets used in the lessons were also attached to each lesson plan.

Validity of the Research Instrument

To establish validity, the initial drafts of the questionnaire and lesson plans were submitted to the thesis adviser for review and face content validation. Additionally, the drafts underwent item inspection by a panel of experts in science, test measurement, and statistics. The experts evaluated each item based on its suitability, relevance, sentence structure, and other pertinent factors. The final draft of the instrument incorporated all the suggested changes, comments, and recommendations for improvement provided by the panel of experts.

Reliability of the Research Instrument

To determine the consistency of the items, the validated questionnaire underwent reliability testing. The researcher conducted a pilot test at Barotac Nuevo National

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Comprehensive High School and administered the instrument to learners not part of the final set of participants.

Their responses were subjected to appropriate computer-processed statistics in the Statistical Package for Social Sciences (SPSS) and analyzed using Cronbach's Alpha with the result of 0.810, which has a very good reliability.

Data Gathering Procedures

The study was experimental in nature; thus, treatment was done for 3 weeks during the school year 2024-2025.

The study determined the effects of game-based learning and conventional learning on the comprehension of scientific concepts of Grade 11 STEM learners. The data needed for the study was obtained through a researcher-made questionnaire during the pretest and posttest.

The data gathering procedure was divided into three stages: pre-experimental, experimental, and post experimental done with full supervision of the thesis adviser.

Pre-Experimental Stage

Upon preparing the research instruments, the researcher obtained the necessary permits to conduct the study. These permits were secured from the Office of the Schools Division Superintendent and the Office of the Schools District Supervisor. Additionally, permits were obtained from the school heads of Barotac Nuevo National Comprehensive High School (for pilot-testing) and Dumangas National High School (for the main study). These permits

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authorized the researcher to conduct the pilot test and the actual study in the respective schools.

The researcher made a matrix of activities of game-based learning and conventional learning in teaching scientific concepts that was followed during the duration of the research. A Table of Specifications (TOS) was developed prior to test construction to proportionate number of test items for each topic. It was submitted to the thesis adviser for review and to the panel of experts for face and content validity and was pilot tested to Barotac Nuevo National Comprehensive High School grade 11 STEM learners.

Purposive sampling technique was used to determine the respondents of the study.

Experimental Stage

The subjects followed the same lesson plans, materials, and references. The teaching sessions adhered to the Senior High School Department's class program for the first quarter of the school year 2024-2025. Specifically, the lessons covered topics such as Earth's Characteristics, Earth's Subsystem, Physical and Chemical Properties of Rocks, Types of Rocks, Importance of Minerals to Society, Ores, and Fossil Fuels, all of which are aligned with the Department of Education's K to 12 science curriculum guide.

Post Experimental Stage

At the end of the three-week period, posttest was administered to the learners.

The data gathered were organized, tabulated, computer- processed, analyzed and interpreted using the appropriate statistical tools.

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Data Analyses

The number of the research instrument was reproduced according to the number of the subjects in the study. The data gathered in the study was organized, tabulated, computer-processed, analyzed and interpreted using the Statistical Package for Social Sciences (SPSS) software.

The researcher based the scale of scores, description and interpretation from the Department of Education grading scale, descriptive equivalent and remarks (Decano et al., 2021).

The rating scale for student performance is as follows:

- Outstanding: 24.01-30.00
- Very Satisfactory: 18.01-24.00
- Satisfactory: 12.01-18.00
- Fairly Satisfactory: 6.01-12.00
- Did Not Meet Expectations: 0.00-6.00

Statistical Tools

The data was tabulated, analyzed, and interpreted using the appropriate statistical tools. All computations were done through social Package for Social Sciences (SPSS) with significance level set 0.05.

Frequency. Frequency was used to determine the number of subjects in both the experimental and control groups.

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Mean. Numerical values were applied to descriptive data to determine the value of the descriptive variable assessed. These yielded the weighted mean scores, the mean gain scores, and the mean of the means of a certain variable.

Mann-Whitney U Test. The Mann-Whitney U test is a non-parametric statistical test used as an alternative to the independent samples t-test for comparing two groups' means when data do not meet the assumptions of parametric tests.

This test was used to determine the significant difference in the pretest results of science concepts between the experimental and the control groups and significant difference in the posttest results of science concepts between the experimental and the control groups.

Wilcoxon Signed Rank Test. Wilcoxon Signed Rank Test is also a non-parametric alternative test to the dependent sample t-test. It is a non-parametric test that was used to compare sample means.

This test was used to determine significant difference between pretest and posttest of science concepts of the experimental group and significant difference between pretest and posttest of science concepts of the control group.

RESULTS AND DISCUSSIONS

The study aimed to find out the effects of two methods of teaching scientific concepts among the Grade 11 STEM learners. The two instructional approaches used in the study were the game-based learning (Experimental Group) and the conventional learning (Control Group). The study was conducted at Dumangas National High School, Ilaya 1st., Dumangas, Iloilo

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during the first grading of the school year 2024-2025. The subjects of the study were the seventy (70) STEM learners of the 11th grade of Dumangas National High School who were purposively selected based on their final average grade in grade 10 and randomly assigned using the toss-coin method.

The teacher utilized the game-based learning in teaching the experimental group and conventional learning in the control group on the topics: Earth's Characteristics, Earth's Subsystem, Physical and Chemical Properties of Rocks, Types of rocks, Importance of Minerals to Society Ores, and Fossil Fuels based on the Department of Education K to 12 Science Curriculum guide.

To gather the data, the researcher used a researcher-made questionnaire which had been validated and pilot tested to establish to reliability. Experimental design was utilized as the research design. The data obtained were tabulated, analyzed, and interpreted using mean descriptive statistics. To determine the significance of the difference among the means, the researcher used the Wilcoxon Signed Ranks test and Mann-Whitney U test. The differences were tested at a 0.05 level of significance.

Prior to exposure to game-based learning, the learners' understanding of scientific concepts was deemed "satisfactory." However, after being exposed to game-based strategies, their comprehension improved to a "very satisfactory" level.

Notably, the posttest mean score revealed a significant increase in the experimental group's understanding of scientific concepts, from "satisfactory" in the pretest to "very

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satisfactory" in the posttest. These results demonstrate that the integration of game-based learning effectively enhanced the learners' understanding of scientific concepts.

There was a significant difference between the pretest and posttest results of the learners in the experimental group using the game-based learning. The understanding of scientific concepts of the learners using the game-based learning was effective in improving the scientific concepts of the learners as shown in the results of the Wilcoxon Signed Rank Test.

The learners' understanding of the scientific concepts before exposure to conventional learning was "satisfactory" and after exposure to conventional learning was also "satisfactory". The posttest mean score shows that the understanding of scientific concepts of the control group did not change from satisfactory level. With the use of the conventional learning, it would reveal that the learning of the learners remains the same using the conventional learning.

There was no significant difference between the pretest and posttest results of the learners in the control group using the conventional learning. The conventional learning was slightly effective to enhance the learners' comprehension of scientific concepts as shown in the results of the Wilcoxon Signed Rank Test.

There was a significant difference in the pretest result of scientific concept mean scores of the learners between the experimental group (game-based learning) and control group (conventional learning) as shown in the results of the Mann-Whitney U Test.

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There was a significant difference in the posttest scores of learners' comprehension of scientific concepts mean scores of the learners between the experimental group (game-based learning) and control group (conventional learning) as shown in the results of the Mann-Whitney U Test.

Conclusions

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

The use of game-based learning is an effective teaching strategy in improving the comprehension of scientific concepts of the learners.

Game-based learning significantly increased the comprehension of scientific concepts of the learners. The learners' active interactions in the game-based activities as instructed by the teacher were responsible for the improvement of the learners' comprehension of scientific concepts.

The use of conventional learning modality was slightly effective in improving the comprehension of scientific concepts of the learners.

Conventional learning showed slight improvement in the comprehension of scientific concepts of the learners. Thus, science lessons can still be taught using conventional learning.

The integration of game-based learning fostered an interactive and immersive learning environment, where learners were actively engaged, challenged, and motivated to share and debate their thoughts. This collaborative approach facilitated deeper understanding and internalization of scientific concepts. In contrast, conventional learning methods, which relied

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on teacher-led discussions, yielded only modest improvements in students' comprehension of scientific concepts.

Both game-based learning and conventional learning can enhance the learners' ability to comprehend and understand scientific concepts.

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