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Digi-Earth: A Quasi-Experimental Study of Digitally Mediated Earth Science Learning On Academic Performance and Learning Retention Among Grade 9 Learners

Andy R. Piedad
Iloilo State University of Fisheries Science and Technology
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ABSTRACT

The academic performance and learning retention of Grade 9 learners' at Bagacay National High School who received digitally mediated Earth Science instruction using the DIGI-EARTH approach were investigated in this study. A pretest, posttest, and delayed retention test were used to evaluate the experimental and control groups in a quantitative quasi-experimental design. There were 30 learner records in the available dataset, 15 in each group. There were thirty items in each assessment. At the.05 significance level, means, standard deviations, paired-samples t-tests, Welch independent-samples t-tests, effect sizes, confidence intervals, and baseline-adjusted regression analyzes were employed. The pretest, posttest, and delayed retention test means for the experimental group were 24.80, 27.13, and 26.73, respectively. The corresponding means for the control group were 22.07, 26.13, and 26.27. From the pretest to the posttest, both groups made significant progress. Posttest scores (p =.159), mean gains (p =.211), and delayed retention scores (p =.472) did not, however, differ statistically significantly between the groups. Additionally, there was no significant experimental-group effect for posttest performance (p =.295) or retention (p =.652) according to baseline-adjusted analyzes. The findings show that both groups made progress, but the data did not show that DIGI-EARTH had a statistically significant advantage over the comparison teaching strategy. Due to the small sample size and substantial baseline difference, results should be interpreted with caution.

Keywords: *Earth science, academic achievement, learning retention, quasi-experimental design, digitally mediated education*

INTRODUCTION

Background of the Study

Learning science improves learners' comprehension of natural phenomena, evidence interpretation, problem-solving skills, and decision-making abilities. The structure and functions of the Earth, natural resources, geological occurrences, weather systems, environmental changes, and interactions between Earth systems are all covered by Earth science. Effective visualization and explanation are crucial elements of instruction because many of these concepts involve processes that cannot be directly observed in a classroom. Scientific information can be presented through animations, simulations, interactive diagrams, videos, multimedia presentations, and online assessment tasks thanks to digital technologies. These resources could assist learners in engaging with scientific representations, visualizing intricate processes, and reviewing explanations. According to multimedia learning principles, information processing can be aided by carefully crafted word and image combinations. But learning cannot be ensured by technology alone. Digital resources must be precise, pertinent, in line with curriculum competencies, and incorporated with practice, feedback, learner activities, and teacher guidance. The teaching of Grade 9 Earth Science at Bagacay National High School in Tigbauan, Iloilo, offers a chance to investigate how digitally mediated instructional resources might enhance academic achievement and learning retention. Both immediate success and the capacity to remember scientific ideas over time are crucial results.

By contrasting students exposed to DIGI-EARTH, a digitally mediated Earth Science learning approach, with learners receiving the comparison instructional approach, this study examined DIGI-EARTH. To investigate initial performance, subsequent achievement, and learning maintenance, pretest, posttest, and delayed retention scores were examined.

Theoretical and Conceptual Foundations

Constructivist viewpoints, which see learners as active participants in developing understanding by making connections between new information and past knowledge and experience, are the foundation of the study. The creation of scientific meaning can be aided by guided investigation, dialog, representation interpretation, and introspection.

The Cognitive Theory of Multimedia Learning also informs this research. Mayer's work highlights coherent, pertinent, and suitably structured multimedia presentations and explains how learners process verbal and visual information. Diagrams, animations, and simulations can be used in Earth Science to depict processes that are challenging to directly

observe. As a result, digital tools are viewed as complements to learning goals rather than as alternatives to good instruction. The study's conceptual framework is Input-Process-Output. Earth science competencies from Grade 9, learner prior knowledge, digital resources, comparison teaching tools, and assessment tools are examples of inputs. Pretesting, monitoring, posttesting, delayed retention testing, statistical analysis, and instructional preparation are all part of the process. Evidence regarding academic achievement, learning retention, group differences, and suggestions for improving instruction are among the outputs.

Statement of the Problem

The purpose of this study was to evaluate the academic achievement and learning retention of grade 9 learners' at Bagacay National High School who were exposed to digitally mediated Earth Science instruction through DIGI-EARTH.

It specifically aimed to sought:

- the academic performance of the experimental and control groups on the pretest and whether there was a significant difference in their scores;
- the two groups' academic performance on the posttest and whether there were any notable differences between their scores;
- the two groups' mean gain scores and whether the gains were significantly different;
- whether each group's improvement from the pretest to the posttest was significant;
- the two groups' delayed learning retention scores and whether there were any notable differences between them;
- whether there were notable changes in each group's posttest and delayed retention scores; and
- whether group differences in posttest and delayed retention remained significant after controlling for pretest scores.

Research Hypotheses

The null hypotheses claimed that there were no significant within-group changes from pretest to posttest or posttest to retention, no significant experimental-group effects on posttest or retention after adjusting for pretest scores, and no significant between-group

differences in pretest, posttest, mean gain, and delayed retention scores at the.05 level of significance. Rather than being considered an intervention effect, the pretest comparison was considered a baseline-comparability assessment.

Significance of the Study

The Department of Education, Bagacay National High School, parents and guardians, science instructors, school administrators, learning resource developers, and future researchers may all benefit from the findings. The results can be used by educators and administrators to direct the creation, assessment, and selection of digital resources. The study could serve as a foundation for more extensive research on technology-assisted science education in the future.

Scope and Delimitations

The study concentrated on Bagacay National High School learners' studying Earth Science in Grade 9. Thirty (30) learner records—fifteen (15) experimental and fifteen (15)control—were included in the available dataset. Each evaluation consisted of a 30-item test with a 30-point maximum score. Pretests, posttests, and delayed retention tests were used to gage the results. The study was restricted to the chosen participants, the subject matter addressed, the learning environment, and the time frame for data collection. Causal claims and generalizations outside of the study setting must be done with caution because the design was quasi-experimental and the groups varied at baseline.

METHODS

Research Design

A control group and an experimental group were included in the study's quantitative quasi-experimental design. A delayed retention assessment was given following the posttest, and both groups were evaluated both before and after the instructional period. O1 is the pretest, X is DIGI-EARTH, C is the comparison instructional approach, O2 is the posttest, and O3 is the delayed retention test. The design is shown as follows: Experimental: O1 – X – O2 – O3; Control: O1 – C – O2 – O3.

Random assignment was not always a part of the design. As a result, when interpreting the results, pre-existing group differences and other potential confounding variables were taken into account.

Locale and Participants

The study was carried out at Tigbauan, Iloilo, Philippines' Bagacay National High School. Thirty (30) Grade 9 learner records made up the analyzed dataset; fifteen (15) were in the experimental group and fifteen (15) were in the control group. The school year, section names, participant selection process, inclusion criteria, and consent arrangements from the authorized research records should all be included in the final manuscript.

Instructional Approaches

DIGI-EARTH, or digitally mediated Earth Science instruction, was the experimental condition. The strategy was created to facilitate the presentation, investigation, practice, and evaluation of Earth Science concepts through the use of digital learning resources and associated educational activities. During the same instructional period, the comparison instructional approach was employed as the control condition. Lessons, materials, teaching time, and teacher activities must all be accurately described in the implementation records; platforms or activities cannot be made up.

Research Instrument

A 30-item multiple-choice Earth Science test with a maximum score of 30 was used to gauge academic achievement and learning retention. The delayed retention test assessed performance after a period of time, the posttest assessed performance after instruction, and the pretest assessed prior knowledge. Only when documented should the test blueprint, content coverage, expert validators, item analysis, pilot-testing process, and reliability coefficient be included in the final manuscript.

Data-Gathering Procedure

Preparing instructional materials and assessment tools, administering pretests, putting experimental and comparison approaches into practice, administering posttests, and conducting delayed retention tests comprised the data collection sequence. Learner scores were arranged according to assessment occasion and group. The researcher's records should be updated with the actual intervention dates, duration of implementation, retention interval, attendance, and fidelity-monitoring protocols.

Statistical Treatment

Group performance was summed up using means and standard deviations. The posttest mean less the pretest mean was used to calculate mean gain. Within-group changes were investigated using paired-samples t-tests. To compare groups, Welch independent-samples t-tests were employed. Standardized effect sizes were described using Cohen's d or dz, and where available, 95% confidence intervals were provided. After adjusting for pretest scores, baseline-adjusted regression analyses looked at group differences in retention and posttest results. The significance level was set at.05. Before characterizing the modified models as a fully verified ANCOVA, assumptions of linearity, homogeneity of regression slopes, residual normality, homoscedasticity, influential observations, and potential class-level clustering should be examined.

Ethical Considerations

In accordance with relevant institutional and Department of Education regulations, research involving students must have the proper school authorization, learner assent, informed parent or guardian consent, confidentiality, secure record handling, and voluntary participation. The final manuscript should list the procedures and approvals that were actually obtained. This draft does not claim ethics clearance or approval without supporting documentation.

RESULTS

The results below are based on the 30 learner records previously supplied for analysis: 15 experimental and 15 control. Scores are out of 30.

Descriptive Statistics

Assessment	Group	N	Mean	SD
Pretest	Experimental	15	24.80	3.34
Pretest	Control	15	22.07	3.56
Posttest	Experimental	15	27.13	1.46
Posttest	Control	15	26.13	2.23

Delayed retention	Experimental	15	26.73	1.98
Delayed retention	Control	15	26.27	1.49

The pretest mean for the experimental group was 24.80, while the control group's was 22.07. The experimental group mean at the posttest was 27.13, while the control group mean was 26.13. The experimental group mean at delayed retention was 26.73, while the control group mean was 26.27.

Between-Group Comparisons

Outcome	Mean difference (Exp – Control)	t	df	p	Decision
Pretest	2.73	2.17	27.89	.039	Significant
Posttest	1.00	1.45	24.10	.159	Not significant
Mean gain	−1.73	−1.28	27.94	.211	Not significant
Delayed retention	0.47	0.73	25.97	.472	Not significant

The experimental group started with a higher mean score, according to the pretest comparison, which was significant (t(27.89) = 2.17, p =.039). With t(24.10) = 1.45 and p =.159, the posttest comparison was not significant. The experimental group's mean gain was 2.33 points, while the control group's was 4.07 points. The between-group gain

difference was not statistically significant (t(27.94) = −1.28, p =.211). Additionally, there was no significant difference in the delayed retention comparison (t(25.97) = 0.73, p =.472).

Within-Group Improvement

Group	Pretest mean	Posttest mean	Mean gain	t	df	p
Experimental	24.80	27.13	2.33	2.50	14	.026
Control	22.07	26.13	4.07	4.16	14	.001

From the pretest to the posttest, both groups significantly improved. 2.33 points were gained by the experimental group (t(14) = 2.50, p =.026). There was a 4.07 point increase in the control group (t(14) = 4.16, p =.001). These improvements within groups do not prove that a particular teaching strategy was better.

Posttest-to-Retention Comparisons

Group	Mean change (Retention−Posttest)	t	df	p
Experimental	−0.40	−0.72	14	.486
Control	0.13	0.22	14	.830

There was no discernible difference between the posttest and delayed retention scores for either group. The mean change for the experimental group was −0.40, t(14) = −0.72, p =.486. The mean change for the control group was 0.13, t(14) = 0.22, p =.830.

Baseline-Adjusted Analyses

Outcome model	Predictor	Coefficient	t	p
Posttest adjusted for pretest	Pretest score	0.073	0.70	.491
Posttest adjusted for pretest	Experimental group	0.801	1.07	.295
Retention adjusted for pretest	Pretest score	0.054	0.55	.584
Retention adjusted for pretest	Experimental group	0.320	0.46	.652

The estimated experimental-group difference for posttest performance was 0.801 points after adjusting for pretest scores, t(27) = 1.07, p =.295, with a 95% confidence interval of [−0.74, 2.34]. With a 95% confidence interval of [−1.12, 1.76], the adjusted group coefficient for delayed retention was 0.320, t(27) = 0.46, p =.652. There was no statistically significant adjusted group effect.

Summary of Findings

· The experimental group had significantly higher initial pretest performance than the control group.

· Both groups improved significantly from pretest to posttest.

· The control group had a numerically higher mean gain, but the between-group gain difference was not significant.

· The experimental group had numerically higher posttest and delayed retention means, but neither difference was significant.

· Baseline-adjusted analyses did not establish a significant experimental-group advantage in posttest performance or delayed retention.

DISCUSSION

The results demonstrate that during the instructional period, students in both groups made progress from the pretest to the posttest. The noteworthy within-group improvements imply that learning took place in both learning environments. However, in terms of posttest performance, mean gain, or delayed retention, the experimental group did not show a statistically significant The substantial baseline difference is an important factor to take into account. Compared to the control group, the experimental group started with a higher pretest mean. This disparity may affect the amount of gain available to each group and makes it more difficult to interpret unadjusted posttest results. Thus, baseline-adjusted regression models were investigated. For the experimental condition, those models yielded positive estimated group coefficients; however, neither of those coefficients was statistically significant.

The findings shouldn't be seen as evidence that DIGI-EARTH has no educational value. Instead, there was insufficient statistical evidence in the available sample to prove that the intervention performed better than the comparison approach in the conditions under investigation. The confidence intervals were wide and the sample size was small. A non-significant result does not prove that the methods are the same.

According to the numerical results, digital resources ought to be taken into account as a component of a more comprehensive instructional design. Learning objectives, clarity, teacher facilitation, active processing, retrieval opportunities, feedback, and review all play a role in how well multimedia resources assist learners in visualizing Earth Science processes. Future iterations of DIGI-EARTH could benefit from formative feedback, spaced retrieval practice, cumulative low-stakes tests, guided inquiry, and misconception checks.

There are restrictions on the study. Thirty (30) learner records from a single school made up the sample. The quasi-experimental design does not guarantee that all confounding variables were controlled, and the groups differed significantly at baseline. The final manuscript must include information on the duration of the intervention, implementation

fidelity, instrument validation, reliability coefficient, and retention interval. Formal assumption checks are also necessary for the adjusted regression models. These restrictions limit the conclusions' power and applicability.

Implications

The results encourage consideration of both digital and non-digital instructional quality in classroom practice. Digital visualizations can be used by educators to present intricate Earth Science procedures while providing opportunities for practice, explanation, discussion, and formative evaluation. Access to suitable devices, offline resources in areas with poor connectivity, and professional development in multimedia instructional design are some ways school administrators can help teachers. Larger sample sizes, improved baseline comparability, well-documented implementation processes, validated tools, and longer-term retention metrics should all be used in future research.

Conclusion

Academic performance significantly improved for both the experimental and control groups between the pretest and posttest. While the control group had a numerically higher mean gain, the experimental group had numerically higher posttest and delayed retention means. Posttest cores, mean gains, and delayed retention scores did not, however, differ statistically significantly between the groups.

Additionally, there was no discernible experimental-group advantage in posttest performance or delayed retention according to baseline-adjusted analyses. Therefore, the conclusion that DIGI-EARTH was statistically better than the comparison instructional approach in this sample is not supported by the results. Additionally, they do not demonstrate that DIGI-EARTH was ineffectual or on par with the comparison method. The proper conclusion is that, given the circumstances of this quasi-experimental study, there was not enough evidence to establish a significant advantage.

Recommendations

- Science teachers may integrate digital materials when aligned with curriculum competencies and accompanied by guided explanation, active learner tasks, formative assessment, and feedback.

· DIGI-EARTH materials may be refined by improving the clarity and accuracy of diagrams, animations, videos, and interactive tasks and reducing unnecessary multimedia elements.

· Teachers may incorporate spaced review, retrieval practice, cumulative quizzes, and corrective feedback to support longer-term retention.

· School administrators may provide appropriate digital resources, offline alternatives, technical support, and professional development in technology-supported science instruction.

· Future researchers should conduct studies with larger samples and stronger procedures for establishing group comparability.

· Future studies should document intervention duration, platforms and materials, attendance, fidelity, retention interval, validation, item analysis, and reliability evidence.

· Researchers may investigate scientific reasoning, conceptual understanding, learner engagement, and attitudes toward Earth Science as additional outcomes.

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