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BRIDGING EDUCATIONAL GAPS: THE EFFECTIVENESS OF AUGMENTED REALITY LEARNING MATERIALS IN THE SENIOR HIGH SCHOOL ALTERNATIVE LEARNING SYSTEM (SHS-ALS)

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ABSTRACT

This research investigates the effectiveness of augmented reality (AR) learning materials in improving the educational outcomes of Senior High School students enrolled in the Alternative Learning System (ALS) in the Philippines. The ALS caters to students who cannot access formal education, often facing barriers such as limited resources, lack of engagement, and diverse learning needs. Recognizing these challenges, this study aims to determine whether AR technology can serve as an innovative tool to enhance learning experiences, promote better comprehension, and increase academic performance among ALS learners.

A mixed-methods research design was utilized, incorporating both quantitative and qualitative data collection techniques. Pre-tests and post-tests measured the students' academic improvement, while surveys and focus group discussions gathered insights into their engagement, motivation, and perceptions toward the AR learning materials. The AR content was designed to supplement applied subjects in the Senior High School curriculum, making lessons more interactive, visual, and accessible.

Findings reveal that students exposed to AR-based learning materials demonstrated significant improvements in their academic performance compared to those who used

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traditional learning resources. Additionally, qualitative feedback highlighted heightened levels of enthusiasm, curiosity, and sustained interest in lessons facilitated through AR. Students reported that AR made abstract concepts easier to understand and helped them connect theoretical knowledge to real-world applications.

The study concludes that integrating AR technology into ALS programs can greatly benefit non-traditional learners by making education more inclusive, engaging, and effective. It recommends that educational institutions and policymakers consider adopting AR tools to address learning disparities and foster a more dynamic alternative learning environment. Further research is encouraged to explore the long-term impact of AR on different subject areas and learner demographics within the ALS framework.

Keywords: *Academic Performance, assessment, Augmented Reality App, quasi-experimental design*

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INTRODUCTION

One of the biggest problems in the Philippines is that many people, especially those from faraway areas and poor families, are still unable to finish their basic education. Reasons like poverty, living far from schools, family duties, and the need to work at a young age often stop them from attending regular classes. To help with this problem, the Department of Education created the Alternative Learning System (ALS). ALS is a special education program that gives out-of-school youth and adults another chance to complete their education. It is flexible and student-centered learners can study at their own pace using modules without needing to attend regular face-to-face classes every day.

Over the years, ALS has given many Filipinos the chance to improve their lives through education. However, there are still challenges, especially for Senior High School (SHS) learners. At this level, the lessons become harder and more complicated. Sadly, many learning materials are still old-fashioned they are mostly plain and full of text, with little pictures or activities. Because of this, students often lose motivation, struggle to understand lessons, and sometimes do not finish the program. In today's world, where technology is part of everyday life, especially for young people, education must also use new ways to catch students' interest and help them learn better.

One new and exciting technology is Augmented Reality (AR). AR adds digital images, videos, and sounds to what students see in real life, making learning more fun and interactive. For example, instead of just reading a lesson, students can scan a picture in their modules using a smartphone to see 3D animations, hear explanations, and answer activities. Studies

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May 2025
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in regular schools have shown that AR can make students more interested in their lessons and help them do better in school.

Even though AR has shown good results in regular schools, there is still very little research about using AR for ALS students. ALS learners often study alone, with less help from teachers, and they face different problems compared to regular students. This is why it is important to study if AR can also help in ALS programs.

This research, titled "*Bridging Educational Gaps: The Effectiveness of Augmented Reality Learning Materials in the Senior High School Alternative Learning System (SHS-ALS),*" aims to find out if an AR Learning Materials App can help ALS students. It will focus on three things: if AR helps students understand lessons better, if it makes them more motivated to study, and if it improves their academic performance.

Through surveys, tests, and feedback from ALS students who use the AR app, the study will collect information to measure how effective it is. The results hope to give new ideas on how technology, especially AR, can make ALS more exciting, effective, and inclusive. By improving learning materials and using modern tools, we can help more learners reach their educational goals and create better futures for themselves and their communities.

Research Question

This study aims to determine the effectiveness of the developed Augmented Reality Learning Materials on the performance of Senior High School Alternative Learning System (SHS-ALS) students in the entrepreneurship subject under the SHS curriculum.

INSTABRIGHT e-GAZETTE
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Specifically, the study seeks to answer the following questions:

1. What are the mean scores of the students in the pretest, formative test, and post-test?
2. Is there a significant difference in the mean score of the formative test between the experimental group (using AR learning materials) and the comparison group (using traditional learning methods)?
3. Is there a significant difference in the mean score of the post-test between the experimental group and the comparison group?
4. Is there a significant difference in the mean scores between the pretest and post-test for each group?

Scope and Limitation of the Study

This study focused on evaluating the effectiveness of a developed Augmented Reality (AR) Learning Application as an alternative learning material for Senior High School (SHS) students enrolled in the Alternative Learning System (ALS). The study was conducted at the SHS-ALS CVLIS in the Calamba City Division during the 2024-2025 school year, beginning in August 2024 and concluding in April 2025. The research specifically aimed to explore the potential of AR technology to enhance the learning experience of students who are part of an alternative education setup, which operates under different schedules and methods compared to traditional schooling.

The study used the quasi-experimental design which tends to get the pre test, formative test and post test of two group which were the experimental and comparison group. This

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

study used pairing random sampling, Mean, standard deviation and t-test. The target population for this study were SHS-ALS Grade 11 students, and the research specifically focused on how the AR learning material app impacted their performance in applied subjects related to entrepreneurship. The AR app was designed to support students in learning on all subjects related to SHS-ALS, a key component of their technical-vocational training.

Framework

The conceptual framework for this research is built on the **Independent Variable-Dependent Variable** model. This framework is essential for understanding the cause-and-effect relationship between the key factors of the study. It identifies how the use of Augmented Reality (AR) as a learning tool impacts students' performance in entrepreneurship, specifically for Senior High School students under the Alternative Learning System (SHS-ALS).

In this study, the **dependent variable** is the performance of the students in the entrepreneurship subject, while the **independent variable** is the use of the Augmented Reality (AR) Learning Materials App. The dependent variable (student performance) is what we are trying to improve or measure in the study, while the independent variable (the AR app) is the factor being tested to see if it has an effect on student outcomes.

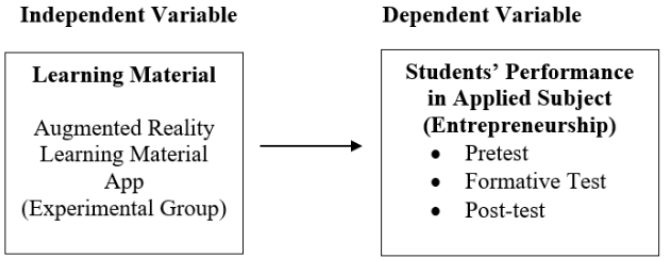

Fig 1. Research Paradigm

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

In this study, the **Independent Variables** and **Dependent Variables** were organized in a way that helps us understand how the use of **Augmented Reality (AR) Learning materials** impacts students' performance in the **entrepreneurship subject**.

The **Independent Variables** are the factors or elements that the researchers change or compare to see if they affect student performance. In this case, the main independent variable is the **learning material** used in the teaching process. There are two groups of students involved in the study: one group uses the **Augmented Reality Learning Material App** (called the **Experimental Group**), while the other group uses the **traditional learning process** (called the **Comparison Group**). By comparing these two groups, the researchers can assess how the use of AR materials influences student learning.

The **Dependent Variables** are the outcomes or results that are measured to see if the independent variable (the learning material) has an effect. In this study, the dependent variable is the **student performance in the entrepreneurship subject**. The researchers measure student performance by giving three types of tests: the **pretest** (before the learning materials are used), the **formative test** (during the learning process to track progress), and the **post-test** (after the learning materials have been used) to evaluate how much students have learned.

By looking at the results of these tests, the study can determine if there is any difference in performance between students who used the AR learning materials and those who used traditional learning methods.

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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To clearly explain how the AR app impacts student performance, the study compares two groups: the **experimental group** and the **comparison group**. The **experimental group** uses the AR Learning Materials App, while the **comparison group** continues to use the traditional learning methods that rely on textbooks and printed modules. The use of AR learning materials serves as the **independent variable**, while the students' performance in entrepreneurship is the **dependent variable** being measured.

In terms of measurement, the dependent variable (student performance) is assessed through various types of tests. These include a **pre-test**, which is administered before the students start using the AR learning materials to measure their baseline knowledge. The **formative test** is conducted during the learning process to assess ongoing progress and understanding, while the **post-test** is given at the end of the learning period to measure the overall improvement in student performance. By comparing the results of these tests, the study will be able to determine if using the AR app leads to better understanding, engagement, and ultimately higher performance in the entrepreneurship subject.

The **AR Learning Materials App** is expected to enhance learning in several ways. First, it provides an interactive, visual, and engaging experience that allows students to better understand abstract concepts and practical skills. Unlike traditional methods that often rely heavily on text, AR materials incorporate multimedia elements, such as videos, animations, and interactive simulations. These elements aim to make the content more relatable and easier to grasp. The use of AR is believed to stimulate interest, increase student motivation, and help them retain information more effectively.

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INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

By focusing on the relationship between the independent variable (AR learning materials) and the dependent variable (student performance), this research aims to provide evidence on whether AR can improve the educational experience for students who are part of the ALS program. Additionally, the study will explore if the use of AR materials can help address the challenges that SHS-ALS students face, such as the difficulty of understanding complex subjects, lack of motivation, and the need for self-paced learning.

Review of Related Studies

The integration of augmented reality (AR) in educational settings has gained significant attention in recent years as a transformative tool capable of addressing learning challenges through immersive and interactive content. This trend highlights the growing role of AR and mobile learning technologies in reshaping educational delivery, particularly in under-resourced or alternative learning environments. In the Philippine context, Manuel and Libo-on (2020) conducted an experimental study on the use of AR in teaching science concepts among Grade 10 students. Their findings revealed that students exposed to AR-enhanced instruction significantly outperformed those taught through traditional methods. Additionally, the study noted increased engagement and interest among learners, supporting the present study's premise that AR can improve comprehension and academic performance—especially in Senior High School (SHS) subjects that often pose difficulties for Alternative Learning System (ALS) learners.

INSTABRIGHT e-GAZETTE
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May 2025
Available online at https://www.instabrightgazette.com

In a related Philippine-based study, Roldan and Dizon (2021) examined the implementation of AR in public school classrooms and found that it had a positive effect on learners' curiosity, motivation, and sustained attention. Students reported improved understanding of lessons and greater enjoyment during AR-facilitated sessions. These findings are particularly relevant to the ALS context, where learners often disengage due to outdated, text-heavy materials. AR, by offering interactive and visually rich content, presents a promising solution for revitalizing the modular learning system commonly used in ALS.

Extending this discourse, Cruz and Santiago (2022) explored the use of AR-enhanced modules in remote communities, including off-grid barangays and alternative learning environments. Their study demonstrated that AR supports self-directed learning—a key component of the ALS framework—by providing contextual visual aids and immediate feedback. These features enabled learners to grasp complex lessons even in the absence of a teacher. The research concluded that AR promotes both comprehension and learner autonomy, making it a suitable tool for flexible and marginalized educational contexts.

Supporting these local insights, Palaoag (2021) investigated the development and implementation of mobile learning tools tailored to the ALS program in the Philippines. His findings highlighted that mobile applications offer practical, learner-centered solutions in areas with limited internet access and educational infrastructure. The study specifically recommended mobile AR apps for their capacity to promote higher-order thinking skills and sustained engagement. This directly supports the design of the AR Learning Materials App

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

featured in the present study, which is optimized for asynchronous, offline use on low-cost smartphones typically available to ALS learners.

From a broader policy perspective, the Department of Education's ALS 2.0 Curriculum Implementation Review (DepEd, 2020) provided critical insights into the persistent challenges of curriculum delivery in non-formal educational settings. The review emphasized the need for innovative, technology-driven resources to better engage learners and reduce educational disparities. It specifically recommended the integration of ICT and multimedia tools to modernize ALS modules and accommodate diverse learning profiles. The current study responds directly to this recommendation by investigating AR as a viable pedagogical tool aligned with ALS's flexible, learner-paced approach.

On a regional scale, Garcia and Dizon (2023) analyzed the use of immersive technologies, including AR and VR, in non-traditional learning environments across Southeast Asia. Their findings highlighted AR's ability to contextualize abstract lessons through interactive media, significantly improving knowledge retention among marginalized learners with limited access to digital tools. Similarly, Seow and Wong (2021) studied AR integration in rural classrooms and emphasized its potential to bridge educational gaps by providing visual and experiential learning opportunities. They observed that students in low-resource settings were more engaged with AR content compared to traditional print-based modules.

In a more recent initiative, Valdez et al. (2024) implemented an AR-assisted vocational training program in Alternative Learning Centers across Mindanao. The study revealed that AR effectively supported the teaching of skill-based competencies—such as food preparation,

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

mechanical repair, and electrical wiring—all of which are part of the SHS Applied Track under ALS. These results affirm that AR can enhance not only academic learning but also practical and competency-based instruction.

Furthermore, Molina and Reyes (2023) assessed the effectiveness of an AR-enabled mobile application designed to improve literacy among out-of-school youth in Metro Manila. The app enabled learners to visualize phonics and grammar rules, leading to notable improvements in reading fluency and comprehension. This highlights AR's broader potential to support foundational skills in ALS contexts, particularly for learners re-engaging with formal education after a significant break.

Finally, Dela Cruz and Hernandez (2025) conducted a quasi-experimental study involving the integration of AR into ALS science modules in Region IV-A. Their research showed significant improvements in both pre-test and post-test scores, along with increased module completion rates and enhanced learner confidence. These findings closely mirror the objectives and preliminary results of the present study, reinforcing the argument that AR-based learning tools can serve as effective interventions for improving educational outcomes in ALS.

Taken together, these recent studies provide a strong empirical basis for the integration of AR in non-formal education. They demonstrate that AR can enrich learning experiences, promote motivation, enhance understanding, and make education more accessible and engaging—especially for learners in alternative settings like the ALS. The present study

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

contributes to this growing body of research by evaluating the impact of AR specifically within the SHS-ALS framework in the Philippines.

Additional recent studies further affirm the relevance and impact of AR in non-traditional and under-resourced educational settings. Capul et al. (2024) developed AR-enhanced instructional materials for Grade 12 Media and Information Literacy classes in the Philippines and found that this significantly improved learner engagement, content mastery, and usability among senior high school students. Similarly, Berame, Bulay, and colleagues (2021) introduced the SIMaTAR mobile AR intervention for Grade 8 science, revealing notable improvements in student performance, motivation, and positive attitudes toward learning. These findings align closely with the present study's focus on improving abstract subject comprehension within the SHS-ALS framework. Complementing this, Besonia et al. (2024) demonstrated the effectiveness of AR tools in strengthening word recognition skills among junior high school students, validating AR's utility in supporting foundational literacy—an essential aspect for many ALS learners who may have gaps in reading fluency.

At the higher education level, Duldulao (2024) conducted a mixed-methods study at Quirino State University, highlighting high acceptance and instructional promise of AR-based modules among faculty and students, which is instructive for planning technology integration in ALS community learning centers. Notably, Melitante (2024) designed and validated an AR learning app specifically for SHS-ALS learners in Calamba, Laguna, confirming its practicality, contextual relevance, and potential to bridge gaps in access and engagement—findings that are directly connected to the current research. In vocational education, Miranda et al. (2020)

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

introduced a 3D simulation tool for engine assembly aligned with SHS technical subjects. Though still in prototype stages, it showed promise for skill-based training, supporting the integration of AR in competency-based ALS tracks.

In humanities education, Garcia (n.d.) used AR storytelling tools to teach Philippine-American colonial history, reporting increased student interest and motivation despite usability limitations. This highlights AR's role in revitalizing interest in content-heavy or less-engaging subjects. Likewise, Morales and Regio (2024) implemented an AR-based learning aid in Grade 7 biology and found that visual and interactive features led to improved retention and conceptual clarity, echoing the benefits AR brings to complex subjects in ALS modules. From a policy and systems lens, Sigua (2021) provided a foresight roadmap for AR integration in Philippine education, emphasizing the importance of infrastructure, policy, and stakeholder alignment. Lastly, Godoy Jr. (2021) proposed a framework combining AR with gamification strategies for Earth Science instruction in senior high school, suggesting that pedagogically sound AR applications can further enhance engagement and cognitive outcomes.

Collectively, these additional studies not only reinforce the academic and motivational benefits of AR but also highlight its scalability, adaptability, and strategic fit for ALS environments. They contribute to a growing body of evidence showing that AR-based instruction, when carefully designed and locally contextualized, can address systemic gaps in engagement, comprehension, and academic performance—goals that align precisely with the objectives of the present study on AR use in the SHS-ALS program.

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

METHODOLOGY

This chapter presents the research design, population and sampling, participants of the study, data gathering instrument, data gathering procedure, and statistical treatment of data.

Research Design

The research follows a quasi-experimental design, which is commonly used when random assignment is not possible. Specifically, a pre-test/post-test non-equivalent group design was employed to compare the learning outcomes of two groups of students: one group using the AR Learning Material App (the experimental group) and another group receiving instruction through traditional methods (the comparison group). This design allows for a comparison of the changes in student performance before and after the intervention, providing a clearer picture of the impact that the AR learning material has on the students' educational progress.

Participants of the Study

The participants of the study were Grade 11 Senior High School Alternative Learning System (SHS-ALS) students from CVLIS, a public Senior High School in Calamba City, Laguna, Philippines, during the school year 2024-2025. Specifically, the study involved only the SHS-ALS Grade 11 section, which was divided into two groups, each containing 13 students, resulting in a total of 26 students. This approach allowed for an even distribution of participants, with each group receiving different teaching methods in the entrepreneurship subject. One group was designated as the control group, which followed traditional

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

instructional practices, while the other group was labeled the experimental group and exposed to the developed Augmented Reality (AR) Learning Material.

Table 1. Result of Match Pairing Based on the Students' Pretest

Group	Students Participants	Blind Participants	Total Population
Experimental	10	3	13
Comparison	10	3	13
Total	20	6	26

As shown in Table 1, there were 20 student participants who actively took part in the experimental treatment and post-test assessment. Additionally, there were 6 blind participants, 3 from each group who were not involved in the experimental treatment but participated in the regular classroom activities. These blind participants helped maintain the flow of the classroom environment and prevented bias that could arise if students knew which group they were assigned to. This also mitigated the Hawthorne effect, where students might alter their behavior if they were aware of being part of a research study.

The total population of the study was 26 students, with 13 students in each group—the experimental group and the comparison group. The matched-pairing process ensured that for every student in the experimental group, there was a counterpart in the comparison group with a similar pretest score, which helped balance the groups. This matching method provided a robust basis for analyzing the effects of the AR intervention on student performance.

By maintaining the same number of blind participants in both groups, the study ensured systematic sampling. This consistency was important because it eliminated group size as a

INSTABRIGHT e-GAZETTE
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Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

potential confounding factor, making it easier to attribute any observed differences in post-test scores to the AR intervention. Furthermore, controlling for pretest differences through matched-pairing strengthened the causal inferences drawn from the study, offering a more reliable understanding of how the AR app influenced students' learning outcomes.

The use of blind participants and matched-pairing not only contributed to the ecological validity of the study but also helped protect the integrity of the classroom environment. By not revealing group assignments to the blind participants, the study preserved the natural classroom dynamics, ensuring that any changes in student behavior could be attributed to the intervention itself rather than external knowledge or influence.

Research Instrument

The research procedures involved several key steps, beginning with the recruitment of participants, who were Grade 11 SHS-ALS students. Following the selection of the participants, the experimental group was introduced to the AR app, while the comparison group continued with traditional learning methods. Over a set period, both groups engaged in learning activities, and data was collected through the tests and surveys administered throughout the study. The students' interactions with the AR materials, as well as their learning progress, were carefully observed and documented.

To analyze the results, statistical analyses were used to determine if there were any significant differences in the academic performance of the two groups. By comparing the mean scores of the pre-test, formative test, and post-test for both the experimental and comparison groups, the study aimed to measure the effectiveness of the AR app in enhancing

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

students' learning outcomes. Statistical tools, such as t-tests, mean, were applied to evaluate the significance of the differences between the groups and to provide empirical evidence regarding the impact of the AR-based learning approach.

Data Gathering

The data-gathering process for this study was carefully planned and executed to ensure the smooth and ethical collection of information. Initially, the researcher sought formal approval to conduct the study by sending a letter to the School Division Superintendent of SDO-Calamba City and the Principal of Camp Vicente Lim Integrated School. This letter outlined the purpose, scope, and significance of the study, as well as the specific permissions requested for conducting research with the SHS-ALS students. Once approval was granted, the researcher proceeded to the next phase of the data collection process.

The first step in gathering data involved the administration of a **validation survey**. This survey was distributed to the selected SHS teachers who provided their expert insights and evaluations of the developed Augmented Reality (AR) learning materials. After the validation process, the researcher proceeded with the **administration of tests** to the participants. This included the pretest, formative tests, and post-test, which were designed to evaluate the students' knowledge and performance in entrepreneurship before and after they interacted with the AR learning materials. The tests were carefully administered, and the researcher made sure that the instructions were clear and understood by all participants. In addition to the traditional testing methods, the students in the experimental group were also introduced to and interacted with the **developed Augmented Reality App** during their

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

lessons. This tool was used as an alternative instructional method to supplement the standard teaching techniques.

Throughout this phase, the researcher exerted significant effort to ensure that the objectives of the study were clearly communicated to all participants. The researcher also ensured that the content of the tests and the AR app was explained in a way that was accessible to the students, enabling them to engage effectively with the materials and participate in the learning process. This clarity in communication was vital for obtaining valid and reliable results.

Once all the tests and interactions with the AR app were completed, the researcher proceeded to **record and tabulate the data**. This involved organizing the test results, observations, and any other relevant information into a format that could be easily analyzed. Finally, the researcher forwarded all the collected data to a **statistician** for the application of the appropriate statistical treatments. These statistical analyses were used to assess the effectiveness of the AR learning materials and determine whether the intervention had a significant impact on students' performance in entrepreneurship.

Through this structured and systematic data-gathering procedure, the researcher was able to collect reliable and valid data that would contribute to the study's aim of assessing the impact of the Augmented Reality learning materials on students' learning outcomes.

Statistical Treatment

The analysis of data in this study was carried out using a set of statistical treatments carefully selected to ensure the accuracy and relevance of the results. These statistical

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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methods were chosen to address the specific research questions outlined in the study and were aligned with the overall goals of evaluating the effectiveness of the developed Augmented Reality Learning Material App. The selection of appropriate statistical tools ensured that the data was analyzed accurately, and the conclusions drawn were based on reliable evidence.

For **Statement of the Problem 1**, which aimed to analyze the mean scores of students in the pretest, formative test, and post-test, **descriptive statistics** were used. Specifically, the **mean** and **standard deviation** were calculated for each test to provide a measure of central tendency and variability in students' performance across both groups. These metrics allowed the researcher to assess the overall performance level of the students and how much variation there was in their scores. Descriptive interpretation scales were applied to categorize the performance results into predetermined categories, such as very high, high, average, low, and very low, thus allowing for a clearer understanding of the students' learning outcomes.

For **Statement of the Problem 2**, which explored whether there was a significant difference in the **mean formative scores** between the experimental and comparison groups, the study applied an **Independent Samples t-test**. This inferential statistical test was chosen because it allows for the comparison of two independent groups to determine whether their means differ significantly. By using this test, the researcher could evaluate whether the experimental group, which used the AR app, performed differently from the comparison group, which followed traditional instructional methods, in their formative assessments.

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INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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For **Statement of the Problem 3**, which sought to determine if there was a significant difference in the **post-test scores** between the experimental and comparison groups, the **Independent Samples t-test** was again used.

For **Statement of the Problem 4**, which aimed to investigate whether there was a significant difference between the **pretest** and **post-test scores** within each group, the **Paired Samples t-test** was employed.

By using a combination of **descriptive statistics**, **Independent Samples t-tests**, **Paired Samples t-tests**, and **effect size analysis**, the study ensured that each research question was addressed using the most appropriate statistical procedure. These measures allowed for both statistical significance and practical significance to be evaluated, ultimately providing a comprehensive assessment of the effectiveness of the Augmented Reality Learning Material App as an instructional tool. Through this robust statistical analysis, the researcher was able to draw reliable conclusions about the impact of the AR app on students' performance in entrepreneurship.

Research Ethics

Throughout the course of this study, the researcher adhered to strict ethical standards to ensure the protection and respect of all participants involved. Ethical considerations are paramount in any research, and the researcher took specific steps to address key issues such as informed consent, confidentiality, and the responsible use of sources.

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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First, the researcher ensured that all participants fully understood the purpose and scope of the study. The aims, objectives, and rationale behind the research were clearly explained to the participants so they were fully informed about their role in the study.

In addition, the researcher emphasized **informed consent**, making it clear that participation was voluntary. No participant was coerced into completing the survey or any part of the research process, and they were informed that they had the right to withdraw at any time without facing any consequences.

To further protect participants, **confidentiality** was a key priority. The personal identities of the respondents were kept confidential throughout the study. Any identifying information, such as names, was not collected or disclosed. The data gathered were used solely for the purposes of this research, and all responses were treated with the utmost care and privacy.

Furthermore, the study was careful to only collect relevant data that directly contributed to the research objectives.

Additionally, the researcher followed ethical standards in handling the works of other authors. All external sources, theories, and studies used in this research were properly **referenced, cited, and quoted**, ensuring that intellectual property was respected and credited.

By addressing these ethical considerations throughout the research process, the researcher ensured that the study was conducted in a fair, transparent, and responsible

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

manner, prioritizing the well-being and privacy of the participants while maintaining academic rigor.

RESULTS

This chapter presents the results of the data gathered in the study, including their analysis and interpretation. The primary objective was to determine the effectiveness of the Augmented Reality (AR) Learning Material App as a teaching aid by comparing student performance across three stages of evaluation: pre-test, formative test, and post-test. These tests were administered to both the experimental and control groups, each consisting of 10 students.

The data presented in Table 2 compares the pretest, formative, and post-test mean scores of students in both the Experimental and Control groups. Initially, both groups had identical mean scores of 25 with a standard deviation of 4.08 in the pretest, which was interpreted as "average." This suggests that prior to the intervention, both groups had similar levels of knowledge or skills in the subject, and their performances were relatively consistent, with no notable differences between the two groups at the beginning of the study.

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

Table 2. Pretest, Formative, and Post-test Mean Scores of the Students in Each Group

Test	Group (n=10)	Mean	Std. Dev.	Descriptive Interpretation
Pretest*	Experimental	25	4.08	Average
	Control	25	4.08	Average
Formative**	Experimental	8	1.10	High
	Control	6	0.67	Average
Post-test*	Experimental	40	4.52	High
	Control	34	3.14	Average

*Legend: *45 – 50 = Very High; 38 – 44 = High; 25 – 37 = Average; 14 – 24 = Low; 1 – 13 = Very Low*
***9 – 10 = Very High; 7-8 = High; 5-6 = Average; 3-4 = Low; 1 – 2 = Very Low*

When moving to the formative test, a noticeable divergence between the two groups emerged. The Experimental group achieved a significantly higher mean score of 8 with a standard deviation of 1.10, which falls into the "high" category. This indicates that the students in the Experimental group not only performed better overall but also showed moderate consistency in their scores. In contrast, the Control group scored an average mean of 6, with a smaller standard deviation of 0.67, which is classified as "average." The smaller standard deviation in the Control group suggests that their scores were more closely clustered around the mean, showing less variability compared to the Experimental group. This comparison reveals that the Experimental group exhibited a better grasp of the material during the formative phase, likely due to the effect of the intervention (the Augmented Reality Learning Material App).

The post-test results further highlight the effectiveness of the intervention. The Experimental group achieved a mean score of 40 with a standard deviation of 4.52, which

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

falls into the "high" category. This result indicates that the students in the Experimental group not only improved from their pretest scores but also demonstrated strong performance after the intervention. On the other hand, the Control group reached a mean score of 34, still within the "average" range, with a standard deviation of 3.14. Although the Control group showed improvement compared to their pretest scores, their progress was less significant than that of the Experimental group.

Overall, the data from Table 2 illustrates that while both groups began with similar levels of knowledge, the Experimental group, which was exposed to the Augmented Reality Learning Material App, showed more substantial improvement and stronger performance across the formative and post-test stages. The results indicate that the intervention had a positive impact on the Experimental group's learning outcomes, suggesting that the use of the AR app was effective in enhancing student performance in the entrepreneurship subject.

Table 3. Difference on the Mean Scores in the Formative Test Between the Experimental and Control Group

	Mean	Std. Dev	p-values	Computed t-values	Decision on H_0	Interpretation
Control	1.90	0.32	0.000*	-4.80	Reject	Significant
Experimental	2.63	0.37				

* *p-value* < 0.05;

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

Table 3 presents the results of the comparison between the Experimental and Control groups in the formative test, revealing a significant difference in their performance. The mean score for the Experimental group was 2.63, with a standard deviation of 0.37, while the Control group had a lower mean score of 1.90 with a standard deviation of 0.32. These results indicate that the Experimental group performed better in the formative test compared to the Control group.

The statistical analysis further strengthens this observation. The p-value of 0.000, which is less than the significance level of 0.05, indicates that the difference in mean scores between the two groups is statistically significant. This means that the observed difference is unlikely to have occurred by chance and is a true reflection of the effect of the intervention. The computed t-value of -4.80 also supports this conclusion, as it is a relatively large negative value that further indicates a significant difference between the two groups' scores. As a result, the null hypothesis (H_0), which posited that there is no difference in performance between the two groups, is rejected.

The rejection of the null hypothesis and the significant p-value point to the conclusion that the intervention applied to the Experimental group had a positive and substantial impact on their performance in the formative test. This suggests that the Augmented Reality Learning Material App used by the Experimental group provided an effective learning tool that enhanced their understanding and retention of the material. In contrast, the Control group, which did not receive the intervention, showed lower performance in the formative test.

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

In summary, the results from Table 3 clearly demonstrate that the Experimental group outperformed the Control group in the formative test, with a statistically significant difference between their mean scores. This reinforces the effectiveness of the Augmented Reality Learning Material App as a tool for improving student learning outcomes in the subject.

Table 4. Difference on the Mean Scores in the Post-test Test Between the Experimental and Control Group

	Mean	Std. Dev	p-values	Computed t-values	Decision on H_0	Interpretation
Control	25	4.08	0.000*	-7.90	Reject	Significant
Experimental	40	4.52				

** p-value < 0.05;*

The data presented in **Table 4** highlights a significant difference in the post-test mean scores between the Experimental and Control groups, underlining the efficacy of the intervention. The Experimental group, which used the Augmented Reality Learning Material App, achieved a notably higher mean score of 40 with a standard deviation of 4.52. This score indicates not only that the students in this group performed strongly but also that there was moderate variability in their performance.

In comparison, the Control group, which did not use the AR-based instructional tool, achieved a lower mean score of 25 with a standard deviation of 4.08. The smaller standard deviation for the Control group suggests that the students' performance was more consistent, but at a significantly lower level than that of the Experimental group.

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

The p-value of 0.000 is a key statistic, as it is well below the standard significance threshold of 0.05. This indicates that the difference in post-test scores between the two groups is statistically significant. Essentially, this means that the improvement in the Experimental group's performance is highly unlikely to have occurred by chance. In other words, the Augmented Reality Learning Material App had a real and measurable impact on the students' ability to perform better on the post-test.

Furthermore, the computed t-value of -7.90, which represents the test statistic used to assess the difference between the two groups, strengthens this conclusion. A negative t-value indicates that the Experimental group scored higher than the Control group, and the magnitude of this t-value suggests a strong and substantial difference between the two groups' results. The extreme value of -7.90 indicates that the improvement observed in the Experimental group was not only statistically significant but also practically meaningful.

Based on these findings, the null hypothesis (H_0), which posited that there was no significant difference in the post-test scores between the Experimental and Control groups, is rejected. Rejecting the null hypothesis confirms that the intervention applied to the Experimental group—namely, the Augmented Reality Learning Material App—had a positive effect on student performance. The Experimental group's post-test scores were significantly higher than those of the Control group, showing that the AR-based tool was an effective instructional aid.

In summary, the results of **Table 4** provide compelling evidence that the Augmented Reality Learning Material App significantly enhanced the learning outcomes of the students in

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

the Experimental group. The higher mean scores in the post-test, combined with the statistical significance of the results, underscore the effectiveness of using AR technology as a teaching aid in the classroom. The stark contrast between the Experimental and Control groups' performance indicates that the intervention had a strong impact, improving students' understanding and retention of the subject matter. Thus, the data strongly supports the conclusion that incorporating AR technology into the learning process can substantially improve students' academic achievements.

Table 5. Pretest and Post-test Assessment of the Two Groups on Effectiveness of the Developed Augmented Reality Learning Materials for SHS-ALS Students

	p-Value	Computed t-values	Decision	Interpretation
Control Pre-test & Post-test	0.000	-10.20	Reject	Significant
Experimental Pre-test & Post-test	0.000	-15.07	Reject	Significant

** p-value < 0.05*

The data in **Table 5** provides a detailed analysis of the pretest and post-test assessment results for both the Control and Experimental groups, specifically focusing on the effectiveness of the Augmented Reality (AR) Learning Materials for Senior High School Alternative Learning System (SHS-ALS) students. The statistical results reveal significant improvements in both groups, but with a greater degree of enhancement observed in the Experimental group, which utilized the AR-based learning tool.

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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For the Control group, the ***p-value is 0.000***, which is well below the standard significance threshold of 0.05. This indicates that the observed difference between the pretest and post-test scores is statistically significant. Additionally, the computed t-value for the Control group is -10.20, which is a highly negative value, suggesting that the improvement from pretest to post-test in the Control group was substantial. As the p-value is less than 0.05, this leads to the rejection of the null hypothesis (H_0), which assumed no difference between the pretest and post-test scores. In other words, the Control group experienced significant learning gains over the course of the study.

Similarly, for the Experimental group, the p-value is also 0.000, reinforcing the significance of the results. The computed t-value for this group is -15.07, which is even more extreme than the t-value for the Control group. This larger t-value further supports the conclusion that the Experimental group experienced a substantial improvement from pretest to post-test. The rejection of the null hypothesis in this case also indicates that the improvement in the Experimental group's scores is statistically significant, confirming that the intervention, which involved the use of AR learning materials, had a positive and measurable impact on their learning outcomes.

The comparison of the t-values reveals an important distinction: while both groups showed significant improvement, the higher t-value for the Experimental group suggests that the AR-supported learning approach led to more pronounced gains. The magnitude of the t-value in the Experimental group indicates that the AR materials were more effective at enhancing students' learning compared to traditional methods, which the Control group

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INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

followed. This suggests that while the Control group benefitted from the learning process, the use of Augmented Reality provided a more robust and impactful learning experience, leading to greater improvements in performance.

In summary, the findings from Table 5 confirm that both groups experienced significant improvements in their performance from pretest to post-test, but the Augmented Reality Learning Materials were particularly effective for the Experimental group. The statistical significance, reflected in both the p-values and t-values, highlights the positive effect of the AR-based instructional tool in enhancing the academic performance of SHS-ALS students. The data suggests that incorporating AR technology into educational practices can provide a powerful learning experience, leading to greater student achievement and better academic outcomes.

CONCLUSION

The conclusions drawn from the study are based on the results obtained from the data analysis, which provide valuable insights into the effectiveness of the Augmented Reality (AR) Learning Materials App in enhancing the learning outcomes of Senior High School Alternative Learning System (SHS-ALS) students in the Entrepreneurship subject. These conclusions are as follows:

1. The null hypothesis is rejected based on the significant difference observed between the level of performance in the formative test of the Experimental and Control groups. The participants in the Experimental group demonstrated a notable increase in their knowledge

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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and proficiency in Entrepreneurship, which resulted in higher scores compared to those in the Control group. This finding concludes that the use of the Augmented Reality Learning Materials App had a meaningful and positive impact on the students' understanding of the subject. The AR tool contributed to better retention of the competencies taught, suggesting that its interactive and engaging features enhanced students' ability to grasp and remember key concepts in Entrepreneurship.

2. The null hypothesis is again rejected, as a significant difference was found between the level of performance in the post-test of the Experimental and Control groups. The substantial improvement in the Experimental group's performance can be attributed to the effectiveness of the Augmented Reality Learning Materials App, which facilitated a deeper understanding of the 1st quarter topics in Entrepreneurship. The results indicate that the use of AR technology in the SHS-ALS setting provided more valuable learning experiences compared to traditional printed modules. The higher post-test scores of the Experimental group confirm that AR-based learning is more contributory to students' academic achievement in this context, enabling them to perform better than their counterparts in the Control group.
3. The null hypothesis is rejected once more, as a significant difference was identified between the pre-test and post-test scores of both the Experimental and Control groups. Although both groups demonstrated learning progress, the data revealed that the Experimental group showed greater gains in performance. This conclusion further supports the idea that the Augmented Reality Learning Materials App had a more substantial positive effect on the participants' learning outcomes in Entrepreneurship. The evidence suggests that while both

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INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

groups benefited from the instructional strategies employed, the AR tool played a more significant role in enhancing students' comprehension and retention of the subject matter.

In conclusion, the study strongly suggests that the Augmented Reality Learning Materials App has a substantial and positive impact on students' learning in the SHS-ALS Entrepreneurship subject. The findings demonstrate that the use of AR technology provides a more engaging and effective learning experience, leading to better performance, improved retention, and a deeper understanding of the competencies being taught. These results underline the potential of AR as a valuable educational tool that can enhance student learning and contribute to better academic outcomes, especially in subjects like Entrepreneurship.

RECOMMENDATIONS

Based on the findings and conclusions drawn from the research study, several recommendations are proposed to enhance the educational experience and further the development of Augmented Reality (AR) technology in teaching, particularly in the context of Senior High School Alternative Learning System (SHS-ALS) students.

1. The research has clearly demonstrated the effectiveness of the developed Augmented Reality Learning Material App in enhancing the learning experience of SHS-ALS students, particularly in the Entrepreneurship subject. Therefore, it is highly recommended that educators consider incorporating AR technology into their teaching methods. This

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

technological tool can provide students with a more engaging and interactive learning experience, enabling them to better grasp complex concepts. Teachers should explore the potential of the AR App to complement traditional teaching methods and enhance students' comprehension and retention of entrepreneurial knowledge.

2. Schools are urged to ensure that students have access to sufficient and appropriate instructional materials, particularly those that incorporate modern technological advancements. Providing students with technology-based learning tools, such as the Augmented Reality Learning Materials App, is essential for preparing them for the demands of 21st-century education. In addition, it is important that schools ensure students have the resources necessary to make the most of such tools, including access to tablets, internet connections, and other technological equipment. By doing so, schools can create a more dynamic and effective learning environment that embraces the power of technology to facilitate learning and broaden students' educational experiences.
3. School administrators, including principals, head teachers, and master teachers, are encouraged to not only support the use of technology-based teaching materials like the Augmented Reality Learning Materials App but also to monitor their implementation. It is recommended that administrators actively engage in ensuring that teachers are using these tools effectively and are integrating them across different subject areas. The potential of AR technology should not be limited to the Entrepreneurship subject but should be explored for use in other subjects as well. Administrators can play a key role in facilitating the

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

adoption of such technologies and ensuring that teachers are well-supported in their efforts to integrate them into their teaching practices.

4. Teachers who wish to develop their own localized Augmented Reality Learning Materials App for specific subject areas should collaborate closely with other educators and digital experts. Collaboration with specialists in digital illustrations and content creation can ensure the production of high-quality, effective teaching materials. These materials can significantly improve students' understanding of complex concepts, providing an interactive and visually engaging experience that goes beyond traditional textbook learning. By working together, teachers can create customized AR learning materials that meet the specific needs of their students and can be easily adapted by other educators for wider use.
5. Finally, it is recommended that future researchers continue to explore the effectiveness of Augmented Reality Learning Apps in enhancing SHS-ALS students' learning outcomes. Further studies could examine the impact of AR-based learning in different educational settings and across various subject areas. Researchers should also consider investigating the application of AR technology across different modalities and teaching environments to further validate the results and optimize the use of these teaching tools. By broadening the scope of research, the educational community can gain a deeper understanding of how to best utilize AR technology in teaching and learning, ensuring that students benefit from the full potential of these innovative tools.

INSTABRIGHT e-GAZETTE
ISSN: 2704-3010
Volume VI, Issue IV
May 2025
Available online at https://www.instabrightgazette.com

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Volume VI, Issue IV
May 2025
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