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Augmented Reality and Academic Performance

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Abstract- *This study employed a quasi-experimental design to determine the effect of Augmented Reality (AR) on the academic performance of non-science Senior High School students in Physical Science. Specifically, it focused on Grade 12 Humanities and Social Sciences (HUMSS) students at Dr. Cecilio Putong National High School in Tagbilaran City, Bohol during the academic year 2024-2025. Sixty students participated in the study, with thirty students in the experimental group receiving AR-enhanced instruction, and thirty in the control group exposed to lecture method. Both groups underwent pre-testing and post-testing. The findings revealed that while both groups showed academic improvement, the experimental group demonstrated a significantly higher gain in their post-test scores. Statistical analyses using dependent and independent t-tests confirmed that the difference in performance was statistically significant in favor of the AR-based group. This suggests that AR tool can effectively enhance conceptual understanding and engagement among non-science students. The study recommends the integration of AR tools in science instruction, the implementation of Learning Action Cell (LAC) sessions for capacity building among teachers, and the development of policies that support immersive educational technologies in public schools.*

Keywords: *Augmented Reality, Academic Performance, Physical Science.*

I. Introduction

Enhancing students' academic performance in science subjects continues to be a formidable challenge in Philippine education, particularly among students in non-STEM tracks such as the Humanities and Social Sciences (HUMSS). These students often exhibit low engagement and poor performance in Physical Science due to the abstract nature of its concepts and the repetitive delivery methods commonly employed in classrooms. Lecture method of instruction tends to limit interactivity and fails to address the diverse learning styles of students. In light of these challenges, educators are exploring innovative strategies, such as Augmented Reality (AR), to provide immersive and interactive learning experiences.

Augmented Reality is a technological innovation that overlays virtual content—such as 3D models and simulations—onto the real-world environment. It allows users to interact with digital information in real-time, thus enhancing their understanding of complex concepts through visualization and manipulation. Numerous international studies have reported the positive impact of AR on student learning, especially in STEM fields. However, there remains a dearth of research exploring its effectiveness among non-science students, particularly in the Philippine context. This study addresses that gap by investigating how Augmented Reality influences the academic performance of Grade 12 HUMSS students in Physical Science.

Grounded in national educational policies such as Republic Act 10533, which mandates the integration of innovative teaching approaches, and DepEd Order No. 42, s. 2017, which promotes technology-enhanced instruction, this study seeks to provide empirical evidence on the efficacy of AR. It aims to determine whether the incorporation of Augmented Reality can revitalize the learning experience, increase student engagement, and ultimately improve academic outcomes in Physical Science among HUMSS students.

II. Literature Review

This study is anchored on several theoretical and empirical foundations. At the core of its conceptual framework is the Cognitive Load Theory (CLT), developed by John Sweller, which emphasizes the optimization of mental effort in instructional design. CLT divides cognitive load into three categories: intrinsic, extraneous, and germane. Intrinsic load relates to the complexity of the material, extraneous load stems from the presentation method, and germane load involves mental effort dedicated to learning (Sweller, 1988). Augmented Reality (AR) helps reduce extraneous load by simplifying complex visualizations and providing interactive simulations, thus facilitating deeper engagement with content (Kirschner, Sweller, & Clark, 2018).

The application of AR in education is further supported by Mayer's Cognitive Theory of Multimedia Learning (CTML). Mayer (2009) claims that combining visual and auditory delivery approaches improves learning. The three tenets upon which CTML is based are active learning, restricted capacity, and dual-channel processing. AR, which combines text, audio, and imagery, caters to these principles by offering learners a multi-sensory experience that fosters meaningful learning and long-term retention (Mayer, 2024).

Connectivism, a learning theory proposed by George Siemens and Stephen Downes, emphasizes the role of digital tools in facilitating connections across various nodes of knowledge (Siemens, 2005). It posits that learning in the digital age is no longer confined to individual cognition but is distributed across networks of people and digital environments. AR exemplifies connectivism by allowing learners to engage in dynamic, context-aware experiences that connect abstract theories with real-world applications.

The Unified Theory of Acceptance and Use of Technology (UTAUT), introduced by Venkatesh et al. (2003), is essential in understanding the behavioral intentions and usage patterns of learners when exposed to new technologies like AR. UTAUT suggests that performance expectancy, effort expectancy, social influence, and facilitating conditions are determinants of

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technology adoption. In the educational context, students are more likely to embrace AR if they perceive it to be useful, easy to use, socially endorsed, and supported by adequate infrastructure.

Numerous studies have demonstrated the benefits of AR in enhancing educational outcomes. Özeren and Top (2023) found that AR reduced students' cognitive load and improved engagement in science subjects. Similarly, Ajit, Lucas, and Kanyan (2021) reported that AR increased students' motivation and helped them understand difficult physics concepts. Ibáñez and Delgado-Kloos (2018) highlighted AR's ability to enhance spatial understanding and abstract reasoning, making it particularly effective for scientific visualization.

In the Philippine context, Morales and Regio (2023) explored the integration of AR in chemistry and found that students using AR showed better performance in laboratory activities. Bautista (2022) emphasized AR's role in demystifying abstract mathematical concepts, while Caro, Boque, and Yang-Ed (2022) confirmed that AR-supported instruction improved long-term retention in science courses. These studies affirm AR's versatility and adaptability across different learning contexts and disciplines.

Despite the promising findings, research on the application of AR in non-STEM fields, particularly the humanities and social sciences, remains limited. Wei et al. (2021) suggest that AR has the potential to improve comprehension in abstract humanities subjects by providing contextual and immersive learning experiences. This gap is especially critical in the Philippines, where access to innovative technologies in public schools is limited. Exploring AR's application among non-science learners can contribute to inclusive education reform and innovation.

Taken together, these theories and studies provide a comprehensive foundation for the current research. They highlight AR's potential to enhance learning through cognitive efficiency, sensory engagement, and interactive experiences, while also addressing the motivational and structural factors that influence technology adoption in schools. By situating this study within this robust theoretical and empirical framework, it aims to advance the discourse on educational innovation in the Philippine senior high school system.

III. Research Methodology

This study utilized a quasi-experimental research design, particularly the non-equivalent control group pretest-posttest design, to investigate the effect of Augmented Reality (AR) on the academic performance of Grade 12 Humanities and Social Sciences (HUMSS) students in Physical Science. This design enabled the comparison between an experimental group, which received AR-based instruction, and a control group, which received conventional lecture-based teaching. The design was chosen to assess learning gains by administering a pretest before and a posttest after the intervention.

The research environment was Dr. Cecilio Putong National High School Senior High School, a public secondary school located in Tagbilaran City, Bohol. The school offers a variety of Senior High School strands including HUMSS and is recognized for its diverse student population and established implementation of the K to 12 curriculum. It was selected as the study site due to its accessibility, availability of instructional resources, and the presence of learners who met the inclusion criteria. The academic setting provided an ideal environment for the integration of AR-based instruction into an actual classroom context.

The study involved a total of sixty (60) Grade 12 HUMSS students who were purposively selected based on their enrollment in Physical Science, regular attendance, and availability of cellular phone devices capable of running AR applications. The students were divided into two intact classes of thirty (30) each. One class served as the control group and received lecture method, while the other class was designated as the experimental group and was taught using AR-enhanced lessons. Prior to the intervention, parental consent and student assent were obtained to ensure ethical compliance. The demographic characteristics of the participants were comparable in terms of academic level and prior exposure to technology, ensuring the validity of the comparative results.

Instruction was carried out over four weeks, with both groups receiving the same lesson content aligned with the DepEd Physical Science curriculum. The experimental group used AR applications such as Star Walk 2 to simulate celestial events and visualize astronomical concepts, while the control group relied on printed modules, PowerPoint presentations, and textbook-based learning. A researcher-made 40-item multiple-choice test, validated by experts and pilot-tested for reliability, was administered as both pretest and posttest. Data were gathered, encoded, and analyzed using descriptive and inferential statistics, including paired and independent sample t-tests at a 0.05 level of significance. The results provided empirical evidence on the effectiveness of AR-based instruction in improving students' academic performance in Physical Science.

IV. Results and Discussions

This section presents the statistical findings and interprets the differences in academic performance between the experimental group taught using Augmented Reality (AR) and the control group taught using traditional lecture-based instruction. The analysis is based on the students' pretest and posttest scores in Physical Science.

Table 1 presents the mean scores and standard deviations of the control and experimental groups before and after the instructional intervention.

TABLE 1. Pretest and Posttest Mean Scores of Control and Experimental Groups

Group	Test Type	Mean Score	Standard Deviation
Control Group	Pretest	26.50	4.32
Control Group	Posttest	30.10	4.87
Experimental Group	Pretest	26.57	4.10
Experimental Group	Posttest	34.83	4.92

The results in Table 1 show that both groups improved in their posttest scores. The control group's mean score increased from 26.50 to 30.10, yielding a mean gain of 3.60 points. The experimental group, however, showed a more substantial improvement, with their mean score rising from 26.57 to 34.83,

a mean gain of 8.26 points. This initial comparison suggests a more pronounced effect of AR-based instruction on student learning outcomes.

To test the significance of the differences within each group, paired sample t-tests were conducted. Table 2 summarizes the result

TABLE 2. Paired Sample T-Test for Pretest and Posttest Scores

Group	Mean Gain	t-value	p-value	Interpretation
Control Group	3.60	5.84	0.000	Significant
Experimental Group	8.26	9.76	0.000	Highly Significant

Table 2 reveals that the improvement in both groups' academic performance was statistically significant at the 0.05 level. However, the experimental group's p-value and t-value suggest a highly significant improvement, indicating that AR played a key role in enhancing their learning. To assess whether the difference in performance between the two groups was statistically significant, an independent sample t-test was conducted on the posttest scores. The results are shown in Table 3.

TABLE 3. Independent Sample T-Test for Posttest Scores Between Groups

Groups Compared	Mean Difference	t-value	p-value	Interpretation
Experimental vs. Control	4.73	3.86	0.000	Highly Significant

As shown in Table 3, the difference in posttest scores between the experimental and control groups is statistically significant at the 0.01 level. This confirms that the use of Augmented Reality significantly enhanced the students' understanding and performance in Physical Science compared to traditional instruction.

These findings are consistent with studies conducted by Ajit et al. (2021) and Özeren and Top (2023), which also found that AR applications significantly improve students' engagement and comprehension in science subjects. The enhanced visualization provided by AR appears to help students better grasp abstract concepts such as planetary motion and celestial phenomena. Furthermore, the interactive and immersive qualities of AR likely contributed to increased motivation and interest in learning.

The results support the theoretical frameworks adopted in this study. According to Mayer's Cognitive Theory of Multimedia Learning, AR facilitates dual-channel processing, allowing learners to simultaneously process visual and auditory information. This enhances retention and understanding. From the perspective of the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), the favorable student response to AR suggests that performance expectancy and effort expectancy were met, increasing student motivation to engage with the material.

The quantitative results strongly support the hypothesis that AR-based instruction leads to greater academic improvement in Physical Science for non-science Senior High School students compared to traditional teaching methods. The significant differences in mean gains and the statistical evidence presented underscore the effectiveness of integrating AR into the science classroom. These findings validate the growing call for innovative teaching methods and contribute to the broader discourse on educational technology in Philippine secondary education.

V. Conclusion

This study concludes that Augmented Reality (AR) is a powerful educational tool that significantly improves the academic performance of Grade 12 HUMSS students in Physical Science. By providing immersive, interactive, and visually enriched learning experiences, AR enhances students' conceptual understanding and engagement, especially in topics often perceived as abstract and difficult. The statistically significant gains in performance underscore the pedagogical value of AR and affirm its alignment with contemporary learning theories and educational reforms. As education continues to adapt to the digital age, AR emerges not just as an alternative instructional strategy but as a transformative force in making science education more inclusive, relevant, and impactful.

Recommendations

The study crafted practical recommendations based on the findings of the study and are addressed to the school administrators, teachers and students.

1. Teachers of Physical Science and other science-related subjects should incorporate AR applications into their instruction to promote interactive and experiential learning.
2. School administrators and curriculum developers should organize Learning Action Cell (LAC) sessions and other training programs to build teachers' technical competencies in using AR tools.
3. The Department of Education should develop policies and allocate funding to support the procurement of AR-compatible devices and applications in public schools.
4. Future researchers should investigate the long-term effects of AR on student learning, retention, and motivation, as well as its applicability across different grade levels and academic tracks.

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