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Development and Validation of a Multimedia-Based Instructional Material

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ABSTRACT

This study addresses the persistent challenges faced by Grade 9 students in understanding abstract Physics concepts, particularly in energy generation, transmission, and distribution, under the MATATAG Curriculum. The purpose of the study was to develop and validate an interactive multimedia-based instructional material, culminating in the gamified tool Grid Guardians, aimed at enhancing students' comprehension, motivation, engagement, and literacy while addressing their least-learned competencies. Guided by the ADDIE model, the study employed a developmental evaluative design and a one-group pre-test–post-test approach. Data were collected using a diagnostic test, pre- and post-tests, expert validation instruments, and perception surveys. Findings revealed that the multimedia-based material significantly improved student performance, as evidenced by the increase in mean test scores from pre-test to post-test and confirmed by paired-sample t-tests ($t = -37.703$, $p < 0.05$). The instructional material was rated very satisfactory in terms of content, format, presentation, accuracy, and usability. The study concludes that evidence-based, learner-centered multimedia tools can substantially improve learning outcomes in Science, particularly for abstract topics. It is recommended that educators integrate such resources into lesson plans, curriculum developers design similar tools for other competencies, and school administrators provide the necessary support and infrastructure to maximize student engagement and comprehension.

Keywords: Interactive Multimedia-Based Instructional Material, Gamification, Grade 9 Physics, Least-Learned Competencies, ADDIE Model, Student Engagement, Learning Outcomes

INTRODUCTION

Science education plays a vital role in developing learners' critical thinking, problem-solving skills, and scientific literacy. However, many Grade 9 students struggle with explaining how electrical energy is generated, transmitted, and distributed. This topic is often viewed as abstract, particularly among learners in rural areas, where textbook examples may not connect with daily experiences. Consequently, text-based and static lessons often result in low engagement and limited understanding. This study developed an interactive multimedia-based instructional material using the ADDIE model to address these challenges. The material incorporated storytelling, visuals, simple animations, and guided activities within familiar local contexts to enhance understanding of energy generation and distribution. Evaluating this tool is necessary to determine its effectiveness in improving comprehension, sustaining motivation, and providing an accessible learning resource despite instructional and connectivity limitations.

Instructional materials support the teaching and learning process by helping learners move from abstract ideas to concrete understanding (Chisunum & Nwadiokwu, 2024). Well-designed materials improve literacy and comprehension, particularly when aligned with learners' needs (Dewi et al., 2024). Integrating storytelling into instruction further strengthens learning by connecting scientific concepts to real-life situations (Tsiouri & Kotsis, 2024). Multimedia-based instructional materials that combine text, audio, and visuals sustain learner motivation and engagement through interactive presentations (Chen & Liu, 2021). The ADDIE model provides a systematic framework for analyzing, designing, developing, implementing, and evaluating instructional materials to address specific learning gaps (Enguito, 2025).

Evidence indicates that students in resource-constrained learning environments often experience difficulties in understanding abstract science concepts when instruction relies mainly on textbooks and lecture-based approaches. In the Schools Division of Surigao del Sur, diagnostic assessments among Grade 9 learners have shown low mastery in explaining how electrical energy is generated, transmitted, and distributed. Similar findings have been reported in other parts of the Philippines, including public secondary schools in the Bicol Region and selected schools in Central Visayas, where students also struggle with electricity-related concepts due to limited instructional materials and reliance on traditional teaching strategies (Azima et al., 2025). Comparable results have likewise been documented internationally, such as in rural schools in Indonesia and selected secondary schools in India, where learners show difficulty understanding electrical systems without the support of visual and interactive learning tools (Peng et al., 2025). Although multimedia-supported instruction has been shown to improve comprehension by integrating visual, textual, and interactive elements, there is still limited research on systematically developed multimedia-based instructional materials aligned with curriculum standards and designed using the ADDIE model to address specific least-learned competencies in Science.

This study aimed to design and develop a multimedia-based instructional material for Grade 9 Science using the ADDIE model to enhance students' literacy, comprehension, motivation, and engagement, particularly in least-learned competencies on how electrical energy is generated, transmitted, and distributed. The instructional material responds to challenges in local school settings, including limited access to updated resources, low learner engagement, and difficulty in understanding abstract Science concepts under the new curriculum. The study contributes local evidence on the effectiveness of narrative-driven, multimedia-based instructional materials in resource-limited public secondary schools in Surigao del Sur. It also provides a context-specific model for developing curriculum-aligned learning resources adaptable to both face-to-face and distance learning, supporting students' understanding and informing teachers, school leaders, and curriculum developers in designing responsive instructional innovations.

LITERATURE REVIEW

Learning Gaps as the Basis for Targeted Physics Instruction

The effectiveness of any instructional intervention rests on its ability to respond to learners' actual needs, making the identification of least learned competencies a critical starting point in science education. Learning gaps in Physics remain persistent due to the abstract nature of concepts, heavy reliance on rote memorization, and weak foundational skills among students (Dai et al., 2024; Sulisworo et al., 2024). Relying on general assumptions about student difficulties often results in mismatched interventions that fail to improve understanding. Diagnostic assessments address this problem by providing concrete evidence of specific conceptual weaknesses. Alerta (2021) stressed that instructional materials developed without diagnostic data risk being ineffective, as they do not directly target the areas where learners struggle most. This argument supports the methodological decision of the present study to anchor material development on diagnostic test results, ensuring that the intervention responds to empirically identified needs rather than perceived gaps.

This need for data-driven intervention is further intensified in the Philippine context, where national and international assessments consistently show low performance in science and literacy. Analyses of the 2022 PISA results reveal that limited reading proficiency significantly constrains students' ability to understand science concepts (Cabural, 2024). Poor literacy skills hinder comprehension of science texts, which then leads to weak conceptual understanding and unfavorable attitudes toward Physics (Caraig & Quimbo, 2022). Such conditions create a cycle where difficulties in reading directly undermine science learning. Addressing science content without strengthening literacy therefore becomes insufficient. DepEd policy directions reinforce this argument by encouraging integrated and inclusive strategies that respond to persistent learning gaps (DepEd Memorandum No. 173, s. 2019). This national situation strengthens the rationale for developing instructional materials that simultaneously address literacy and Physics competencies.

Moreover, research on Strategic Intervention Materials and similar targeted resources provides empirical support for this approach. Studies show that instructional materials designed around least learned competencies can significantly improve student performance. Maravilla and Aliazas (2024) demonstrated that contextualized science modules increased mastery levels, while Kim et al. (2021) reported gains in both literacy and science achievement through integrated interventions. However, effectiveness is not guaranteed. Barrot (2023) cautioned that intervention materials must be carefully aligned with diagnosed competencies and curriculum standards, as poorly aligned resources may confuse learners rather than support them. This reinforces the central argument that diagnostic results should directly guide content selection and design. Grounding the multimedia-based instructional material on identified least learned competencies ensures that it functions as a focused, relevant, and pedagogically sound response to documented learner needs.

Educational Foundations of Multimedia and Narrative Learning

The development of an effective interactive multimedia-based instructional material requires a strong theoretical justification that explains *why* and *how* such tools can improve learning. Mayer's (2020) Cognitive Theory of Multimedia Learning provides this foundation by arguing that students achieve deeper understanding when words and visuals are meaningfully integrated rather than presented in isolation. Poorly designed multimedia can overload learners, but well-designed materials support essential processing and knowledge construction. This position supports the study's decision to design an interactive material that deliberately integrates narration, visuals, and activities to improve comprehension and literacy. Yet, cognitive efficiency alone is insufficient. Bhandare (2025) and Grigorescu (2020) show that multimedia narratives increase curiosity and emotional connection, which strengthens motivation. These findings suggest that instructional materials must address both cognitive processing and learner motivation to be effective.

Further, narrative-based learning further strengthens this argument, especially in Physics where concepts are often abstract and difficult to visualize. Stories organize information into meaningful sequences, helping learners understand cause-and-effect relationships that are central to physics concepts (Reyes & Villanueva, 2024). Embedding scientific ideas within narratives also supports literacy development, since vocabulary and concepts are introduced in familiar and contextualized ways that reduce reading difficulty and cognitive load (Khair & Misnawati, 2022). Empirical evidence supports this approach, as Tran et al. (2023) found that narrative-based science instruction improves conceptual understanding and learner engagement. However, this approach is not without limitations. Höttecke and Allchin (2020) caution that narratives may oversimplify or misrepresent scientific processes if accuracy is sacrificed for storytelling. This critique underscores the need for instructional materials that balance narrative appeal with scientific rigor.

Collectively, these perspectives support the argument that interactive multimedia storytelling offers a pedagogically sound response to identified learning gaps. Interactivity transforms learners from passive recipients into active participants, allowing them to control pacing, respond to prompts, and receive feedback, which deepens engagement and supports knowledge construction (Rose & Johnson, 2025). This aligns with constructivist views that learning occurs through active meaning-making rather than passive exposure (Hasibuan, 2025). Therefore, the study argues that an interactive multimedia storybook is not merely a creative presentation tool but a theoretically grounded instructional environment where cognitive principles, narrative structure, and learner interaction work together. Such integration directly addresses motivation, engagement, literacy, and comprehension, which are the core concerns of this study.

Design, Development, and Validation Frameworks for Instructional Materials

The development of a credible and effective instructional resource demands more than creativity; it requires a systematic framework that ensures pedagogical soundness and responsiveness to learner needs. The ADDIE model remains a widely accepted instructional design framework because its structured yet adaptable phases promote learner-centered development (Abuhassna et al., 2024). Its relevance to this study is evident, as each phase directly corresponds to the research process. Diagnostic test results inform the analysis phase, targeted competencies guide the design and development of the interactive material, classroom use occurs during implementation through field tryout, and effectiveness is measured during evaluation using pre-test, post-test,

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and perception data. This alignment strengthens the argument that ADDIE is not merely a procedural guide but a methodological backbone that ensures coherence between research objectives and instructional outcomes. Although critics argue that ADDIE can be linear and time-consuming (Perez & Galinski, 2024), its iterative nature allows for continuous improvement. Adopting a flexible approach within the model, supported by early validation and rapid prototyping, addresses these limitations while preserving instructional rigor (Ochieng, 2025).

Beyond development, validation is essential to establish the instructional material's quality, relevance, and acceptability. Effective validation must be multidimensional, since instructional materials operate at the intersection of content accuracy, pedagogical design, and learner usability. Organizing validation criteria into content, format, presentation and organization, and accuracy provides a comprehensive lens for evaluation. Empirical evidence supports this approach. Shakeel et al. (2023) found that materials evaluated using multiple quality dimensions demonstrated higher validity and classroom usability. Content validity depends on alignment with curriculum standards and diagnosed learning gaps, while format and presentation quality are best evaluated using principles from multimedia learning, such as coherence and visual-text alignment (Mayer, 2020; Barrot, 2023). Accuracy and up-to-datedness remain critical, particularly in science education, where conceptual errors or oversimplifications can mislead learners (Höttecke & Allchin, 2020).

The validation process gains greater credibility when it incorporates multiple perspectives. Research consistently shows that involving experts, teachers, and students produces more balanced and actionable evaluations (Pingil, 2022; Spatioti et al., 2022). Experts safeguard scientific accuracy and curricular alignment, while teachers and students highlight usability, engagement, and classroom realities. Differences in validation ratings among these groups are not weaknesses but valuable data points. Teachers may emphasize instructional feasibility, whereas students may prioritize clarity and engagement, as observed by Belda-Medina and Goddard (2024). Examining these variations allows the study to move beyond simple acceptance or rejection of the material toward a deeper understanding of how it functions across stakeholders. This evidence-based approach ultimately informs the enhancement of the interactive multimedia-based instructional material, ensuring it is both educationally sound and practically effective.

Impact, Efficacy, Challenges, and Teacher-Student Perceptions

Determining whether an instructional intervention truly works requires more than good intentions; it demands a sound method for proving impact. The pre-test and post-test design used in this study is widely accepted as a reliable way to measure learning gains directly attributed to an intervention. Studies have shown that this approach can clearly demonstrate improvements in student performance after exposure to targeted instructional materials (Aulia & Prahmana, 2022; Maravilla & Aliazas, 2024). A significant increase in post-test scores would therefore provide strong evidence that the interactive multimedia-based material improves students' understanding of least-learned Physics competencies. Yet, researchers caution that test scores alone cannot fully explain effectiveness, since they do not reveal how learners experience or use the material in real classroom contexts (Snell & Helen, 2020).

For this reason, examining both student and teacher perceptions becomes essential. Student feedback on motivation, engagement, and clarity helps determine whether the material meets its intended cognitive and affective goals, with prior studies showing that positive perceptions of narrative-based multimedia are linked to higher participation and sustained effort (Jiménez-Valverde, 2025; Sari et al., 2024). Teacher perceptions provide a complementary lens, focusing on curriculum alignment, classroom feasibility, and instructional practicality. Differences between student and teacher ratings are not contradictions but valuable insights, as teachers may acknowledge strong content quality while noting challenges in time, pacing, or classroom management, consistent with findings from Belda-Medina and Goddard (2024).

No instructional innovation is free from obstacles, particularly when technology is involved. Previous studies consistently report challenges such as limited access to devices, unstable internet connectivity, varying levels of digital skills, and difficulty fitting new materials into an already dense curriculum (Bautista, 2021; Barrot, 2023). Multimedia narratives also pose specific risks, especially when interactive features distract rather than support learning goals (Li & Sun, 2024). Identifying these challenges strengthens, rather than weakens, the study, since it allows for realistic refinement of the tool. As emphasized by Perez and Galinski (2024), understanding implementation issues is necessary for proposing practical enhancements, ensuring that the final output is not only effective in theory but also usable and sustainable in actual classroom settings.

METHODOLOGY

Research Design

This study used a developmental evaluative research design guided by the ADDIE model; Analysis, Design, Development, Implementation, and Evaluation, to systematically create and refine a multimedia-based instructional material for Science 9. Developmental research is appropriate for producing and validating instructional materials that respond to identified learning needs, while the ADDIE model provides a structured, flexible process supporting learner-centered and theory-based design (Molenda, 2015; Abuhassna et al., 2024). The diagnostic results on the least-learned competency, particularly on how electrical energy is generated, transmitted, and distributed, directly informed the analysis, design, development, implementation, and evaluation of the instructional material.

The study employed a one-group pre-test–post-test quasi-experimental design. Grade 9 students completed a pre-test before the implementation of the multimedia material and a post-test after the intervention. The differences between pre-test and post-test results were statistically analyzed to determine the effectiveness of the material in improving students' learning outcomes. This design was deemed appropriate because the study was conducted in an actual classroom setting where random assignment and the use of a control group were impractical. Nevertheless, the absence of a control group limits the ability to attribute improvements in student performance solely to the intervention, as other factors such as maturation, testing effects, and external influences may have contributed to the observed changes.

Research Locale

This study was conducted at Adlay National High School within the Schools Division of Surigao del Sur. The school was purposively selected because it implements the K to 12 curriculum and serves learners with diverse academic abilities and socioeconomic backgrounds, providing a representative setting to examine the effectiveness of classroom instructional interventions. Adlay National High School was particularly appropriate for this study because it faces persistent challenges in science learning, especially in literacy, comprehension, and engagement in abstract concepts such as explaining how electrical energy is generated, transmitted, and distributed. These challenges align with the issues targeted by national programs, including the 3Bs Initiative (DepEd Memorandum No. 173, s. 2019), which aims to improve learning outcomes in resource-limited contexts. Conducting the study in this school allowed the researcher to evaluate the practicality, relevance, and impact of the developed multimedia-based instructional material in an authentic classroom environment, ensuring that the findings are meaningful for local educational practice and potentially scalable to similar contexts.

Research Respondents

The study used purposive sampling to select expert evaluators and Grade 9 student participants to support both the developmental and quasi-experimental components (Adeoye, 2023). A total of 30 Grade 9 students from Adlay National High School participated. They were selected based on enrollment in Science, regular attendance, and no prior exposure to the developed multimedia material. Intact classes were used to maintain the natural classroom setting in line with quasi-experimental design principles (Creswell & Guetterman, 2019). However, the use of purposive sampling and the inclusion of participants from only one school limit the generalizability of the findings. Since the respondents represented a specific group of Grade 9 students from a single educational setting, the results may not fully reflect the experiences or learning outcomes of students from other schools, grade levels, or contexts. Consequently, caution should be exercised when extending the findings to broader populations. For expert validation, 10 key informants were selected, including Science/Master Teachers, LRMDS personnel, language experts, and media/design specialists. All had at least three years of relevant experience in curriculum implementation, instructional supervision, or learning resource evaluation. Science teachers focused on content accuracy, LRMDS staff on curriculum alignment, language experts on clarity, and media specialists on design and interactivity. This ensured that the validation process was both pedagogically and technically grounded (Ramezani & Mostafavi, 2025). Nevertheless, the relatively small number of expert validators and their selection through purposive sampling may limit the diversity of perspectives obtained during the evaluation process. Despite this limitation, the chosen experts possessed the necessary qualifications and experience to provide informed and credible assessments of the developed multimedia material.

Research Instrument

To address the research problems, validated instruments were used to identify least-learned competencies, evaluate the instructional material, and measure student performance. A researcher-developed diagnostic test aligned with DepEd MELCs was validated by experts and used to determine learning gaps, which guided the development of the instructional material. The DepEd Learning Resource Evaluation Tool and a student questionnaire were used to assess content, format, presentation, and accuracy. Pre-test and post-test instruments measured students' prior knowledge and learning gains after the intervention. Both tests were parallel in content and difficulty. Results provided quantitative evidence of improvement in performance. Overall, the instruments demonstrated acceptable reliability, with a Cronbach's alpha of 0.75, indicating sufficient internal consistency for educational research (Henson & Roberts, 2024).

Data Gathering Procedure

Prior to data collection, the researcher secured approval from the Schools Division of Surigao del Sur and permission from the principal of Adlay National High School. Coordination meetings were conducted with school heads and Science teachers to finalize schedules, orient stakeholders, and identify participating Grade 9 classes. These steps ensured ethical compliance, preparedness, and proper implementation. The study followed the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). In the Analysis phase, a diagnostic test identified least-learned competencies in Physics, particularly on electrical energy generation, transmission, and distribution, which guided the design of the instructional material.

In the Design phase, the multimedia-based material was developed using storytelling, gamification, and interactive simulations aligned with curriculum objectives and learner needs. During Development, the initial version was validated by experts using the DepEd LRMDS Evaluation Tool, and revisions were made based on feedback to improve clarity, usability, and instructional quality. A student evaluation tool was also used to assess engagement, motivation, and comprehension. In the Implementation phase, the revised material was used in an intact Grade 9 class. Students completed a pre-test, engaged with the instructional material, and then took a post-test. Classroom observations and student feedback were also gathered to support quantitative findings. Finally, the Evaluation phase integrated expert validation, test results, and feedback to refine the instructional material, ensuring it was effective, evidence-based, and suitable for Science instruction.

Statistical Treatment

The quantitative data were analyzed using appropriate statistical tools to determine the effectiveness and acceptability of the instructional material. Frequency count and mean percentage were used to identify least-learned competencies from the diagnostic test. Mean and standard deviation described students' pre-test, post-test, and evaluation results. The Wilcoxon Signed-Rank Test was used to determine the significant difference between pre-test and post-test scores after the intervention.

RESULTS AND DISCUSSION

Identified Least Learned Competencies of Grade 9 Students

The diagnostic test conducted during the fourth quarter identified the specific competencies in which Grade 9 students exp erienced the greatest difficulty. Table 1 presents these competencies, including the corresponding items, mastery classifications, and mean percentage scores (MPS). The mastery levels were classified as very low, low, and moderate, providing a clear framework for prioritizing instructional interventions.

Table 1. Least Learned Competencies

Competency	Items	Mastery Level	Mean Percentage Score (MPS)
Explain how electrical energy is generated, transmitted, and distributed (S9FE-IVh-j-46)	16, 23, 30, 42, 47	Very Low (≥60% incorrect responses)	38.5
Explain how heat transfer and energy transformation make heat engines work (S9FE-IVg-45)	2, 11, 41	Low (41–60% incorrect responses)	55.0
Relate impulse and momentum to collision of objects (e.g., vehicular collision)	18, 37	Low (41–60% incorrect responses)	52.0
Infer that the total mechanical energy remains the same during any process (S9FE-IVe-41)	17	Moderate (21–40% incorrect responses)	63.0
Describe the horizontal and vertical motions of a projectile (S9FE-IVa-34)	49	Moderate (21–40% incorrect responses)	68.0

The top-ranked competency, explaining how electrical energy is generated, transmitted, and distributed, was classified as very low mastery. This indicates a significant gap in students' conceptual understanding across several items, making it the highest priority for targeted intervention. Addressing this competency is critical because it serves as a foundational concept for more advanced topics in electrical energy systems and power distribution.

The very low level of mastery may be attributed to the abstract and invisible nature of electrical processes. Students often struggle to understand how energy moves through systems because these processes cannot be directly observed in everyday experiences. According to cognitive load theory, learners may experience difficulty when complex, multi-step scientific processes are presented in purely verbal or text-based formats without adequate visual support (Sweller, 2011). This situation is further intensified when instruction relies heavily on traditional lecture methods, which limit opportunities for visualization and conceptual interaction.

Maravilla and Aliazas (2024) emphasized that learners demonstrate better understanding of physics-related concepts when instructional materials incorporate visual representations and interactive elements. Similarly, Ijiga et al. (2021) found that students exposed to multimedia and simulation-based instruction showed significantly improved conceptual comprehension compared to those taught using conventional approaches. These findings align with Mayer's Cognitive Theory of Multimedia Learning, which suggests that combining visual and verbal information improves meaning-making and reduces cognitive overload (Mayer, 2009).

Furthermore, misconceptions about electricity are commonly reported in science education literature. Students often hold alternative conceptions, such as viewing electric current as something that gets "used up" rather than continuously flowing in a closed circuit, which affects their understanding of generation and distribution systems (Engelhardt & Beichner, 2004). These misconceptions make it more difficult for learners to grasp system-level processes without structured conceptual scaffolding.

Given these challenges, the use of multimedia-based instructional materials, including diagrams, animations, videos, and simulations, becomes essential. Such tools provide concrete visualizations of otherwise abstract processes, helping students build accurate mental models of how electrical energy is generated, transmitted, and distributed, thereby improving both understanding and retention of the concept.

Perceptions of the Respondents to the Developed Instructional Material

Table 2 presents the weighted mean scores (WM) and verbal interpretations of respondents' perceptions regarding the developed interactive multimedia-based instructional material. Across all evaluated indicators namely: content, format, presentation and organization, and accuracy and up-to-datedness of information, the material received high ratings, classified as **Very Satisfactory**.

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The respondents' perceptions of the developed interactive multimedia-based instructional material were highly positive, with all indicators rated "Very Satisfactory." The material was found suitable for students' development, aligned with learning objectives, and effective in enhancing higher-order thinking skills such as critical thinking, creativity, and problem-solving.

Table 2. Respondents' Perceptions on the Developed Instructional Material

Variables	**WM**	**Verbal Interpretation**
Content	3.80	Very Satisfactory
Format	3.64	Very Satisfactory
Presentation and Organization	3.88	Very Satisfactory
Accuracy and Up-to-datedness of Information	4.00	Very Satisfactory
Average	**3.83**	**Very Satisfactory**

Legend: 3.26 – 4.00Very Satisfactory (VS), 2.51 – 3.25Satisfactory (S), 1.76 – 2.50Poor (P)1, .00 – 1.75Not Satisfactory (NS)

The evaluation of content indicates that respondents found the material highly effective in terms of its scope, relevance, and alignment with learning objectives. This suggests that the instructional content addressed the identified least-learned competencies and supported students' comprehension of abstract scientific concepts. The positive perception is consistent with findings in the literature, which emphasize that well-structured and accurate instructional content enhances learners' understanding and promotes active learning in Science (Delos Santos & Fiscal, 2024).

Regarding format, the material received a very satisfactory rating. Respondents highlighted the appropriateness of illustrations, font readability, color schemes, and overall visual appeal. The slightly lower score compared to content may indicate minor areas for refinement, such as increasing interactivity or adapting the visual design to further sustain attention. Mitra and Mortera (2025), supports the view that well-designed instructional formats, including the effective use of visuals and layout, are essential in maintaining learner engagement and enhancing comprehension.

The variable presentation and organization received the highest, reflecting respondents' positive perception of the logical sequence of ideas, clarity of instructions, and accessibility of the material. This suggests that the material was structured in a way that facilitated smooth progression of lessons and promoted better understanding. Pantaleon (2026) indicates that logically organized multimedia materials enhance cognitive processing, thereby supporting learners' comprehension and retention of complex concepts.

Finally, accuracy and up-to-datedness of information received the highest among all variables, demonstrating that respondents found the content free from factual, conceptual, grammatical, or computational errors. This indicates that the material is reliable and aligns with current scientific knowledge, which is essential for fostering trust and ensuring effective learning outcomes. Studies highlight that accuracy in instructional materials enhances students' confidence in using the resources and supports meaningful engagement with the content (Dai et al., 2024; Freitas, 2024).

Therefore, the high ratings across all variables indicate that the multimedia-based instructional material is well-designed, pedagogically sound, and effective in supporting student learning. The findings suggest that such materials can enhance engagement, comprehension, and confidence in Science learning. The slightly lower score for format highlights an opportunity for further refinement, potentially by incorporating additional interactive elements or adaptive visual features to maintain learner attention. These results underscore the importance of integrating high-quality multimedia resources in lesson planning to create an engaging, accurate, and well-organized learning environment that supports diverse student needs.

Pre-test and Posttest Mean Scores

The pre-test results show a minimum score and a maximum score, with a mean and a standard deviation. These results indicate that, prior to using the multimedia material, students had a relatively narrow range of scores,

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with most students performing at a moderate level on the test. The standard deviation suggests there was some variability in the scores, but overall, the students' performance was fairly consistent within a small range.

Table 3. Pre-test and Posttest Mean Scores

Test	Mean	Std. Deviation
Pretest	10.1333	1.92503
Posttest	23.7333	2.27328

Table 3 presents the mean scores and standard deviations for the pre-test and post-test administered to Grade 9 students. The pre-test results indicate moderate performance, with scores generally clustered around the mean. The relatively low standard deviation suggests that student performance was fairly consistent across the group, reflecting a similar baseline understanding of the targeted Physics competencies. The post-test results reveal a marked improvement, with a substantially higher mean score. This indicates that students' performance improved considerably after using the multimedia-based instructional material. The slightly higher standard deviation compared to the pre-test suggests some variability in learning gains, with certain students exhibiting greater improvement while others showed steady but strong performance.

The improvement in post-test scores can be explained by the instructional features embedded in the multimedia material. The integration of visual representations, animations, and simulations helped make abstract Physics concepts more concrete and easier to understand. According to Mayer's Cognitive Theory of Multimedia Learning, students learn more effectively when verbal explanations are combined with relevant visual representations, as this supports dual-channel processing and reduces cognitive overload (Mayer, 2009). This may explain why learners were able to better grasp complex ideas after exposure to the material.

In addition, the interactive nature of the instructional material likely contributed to sustained attention and engagement. Multimedia learning environments that allow students to explore concepts actively rather than passively receiving information tend to improve conceptual understanding and retention. This aligns with constructivist learning principles, where learners build knowledge through meaningful interaction with content. The structured pacing and step-by-step presentation of concepts may have also supported learners with varying ability levels. Students who initially struggled were able to revisit explanations and visualize processes repeatedly, while more advanced learners were able to deepen their understanding through guided exploration.

This flexibility in learning pace is a known advantage of multimedia-based instruction. These results support the efficacy of multimedia-based instructional materials in enhancing learning outcomes, particularly in improving conceptual understanding, engagement, and knowledge retention in Physics topics that are typically abstract and difficult to visualize. Aulia and Prahmana (2022) and Kim et al. (2021) indicates that interactive and engaging multimedia tools, including videos, simulations, and visual graphics, enable students to better visualize and understand complex scientific concepts, resulting in higher performance on assessments. Similarly, Barrot (2023) notes that multimedia-based instruction facilitates deeper learning by making abstract concepts more accessible, thereby improving engagement and academic achievement.

The notable improvement in post-test mean scores highlights the potential of multimedia materials to support comprehension and cater to diverse learning preferences. The slight variability in the post-test scores suggests that while most students benefited significantly, the level of improvement may depend on individual engagement with the material or differences in learning styles. These findings imply that future implementations should consider providing additional guidance or differentiated support to ensure all students can achieve consistent gains, thereby maximizing the impact of multimedia-based instruction in Science education.

Significant Difference on the Pretest and Posttest of the Students During the Field Tryout

Table 4. Significant Difference between Pretest and Posttest

Test	t-value	p-value	Decision	Interpretation
Pretest	-37.703	0.000	Reject H_0	There is significant difference
Posttest				

Table 4 presents the results of the paired samples t-test comparing pretest and posttest scores of Grade 9 students. The analysis reveals a t-value of -37.703 with a p-value of 0.000, which is below the 0.05 significance level. Based on these results, the null hypothesis (H_0) is rejected, indicating a statistically significant difference between the pretest and posttest scores. This demonstrates that students' performance improved significantly following the implementation of the multimedia-based instructional material.

The findings suggest that the interactive multimedia-based material effectively enhanced student learning outcomes in Physics. The significant improvement in scores reflects the effectiveness of multimedia tools, such as videos, interactive simulations, and visual representations, in supporting learners' comprehension and retention of complex concepts (Metro, 2026). These tools appear to have made abstract topics, such as the generation, transmission, and distribution of electrical energy, more accessible and engaging, which contributed to higher posttest performance.

The results have important implications for instructional practice. Integrating multimedia-based materials into teaching strategies can enhance student motivation, engagement, and understanding, particularly in subjects that involve abstract or technical concepts like Physics. The strong statistical significance of the improvement further supports the use of interactive, visually rich resources to complement traditional instruction. Future implementations may explore the use of varied multimedia formats and investigate their long-term effects on student comprehension, retention, and application of scientific knowledge.

CONCLUSION

The findings of this study indicate that Grade 9 students exhibited significant learning gaps in key Physics competencies, particularly in explaining the generation, transmission, and distribution of electrical energy, which was identified as the most difficult area among the least learned competencies. This suggests that abstract and system-based concepts in Physics remain challenging for learners when presented through traditional instructional approaches. These difficulties are further reflected in students' baseline performance, highlighting the need for more concrete and visually supported learning experiences.

The developed interactive multimedia-based instructional material was found to be highly acceptable by respondents, with all evaluated aspects rated as very satisfactory. This indicates that the material is well-aligned with learning objectives, accurately presented, and appropriately designed to support learner engagement and comprehension. More importantly, the substantial increase in post-test scores, compared to pre-test results, demonstrates that the use of multimedia instruction significantly improved students' conceptual understanding and academic performance. The statistical analysis further confirms that this improvement is significant, indicating that the intervention had a strong positive effect on learning outcomes. Thus, the study concludes that multimedia-based instructional materials are effective in enhancing students' understanding of complex Physics concepts, particularly those involving abstract processes such as electrical energy systems. The results support the integration of visually rich and interactive learning tools in Science instruction to address learning gaps, improve engagement, and promote meaningful understanding among learners.

REFERENCES

1. Abuhassna, H., Alnawajha, S., Awae, F., Adnan, M. A. B. M., & Edwards, B. I. (2024). Synthesizing technology integration within the ADDIE model for instructional design: A systematic review. Journal of Autonomous Intelligence, 7(5), 1–28. https://doi.org/10.32629/jai.v7i5.1546
2. Adeoye, M. A. (2023). Sampling techniques in educational research. ASEAN Journal for Science Education, 2(2), 87–94.
3. Alcazar, A. A. M. (2023). Education equity and the SDGs in the Philippines. Eubios Journal of Asian and International Bioethics, 33(3).
4. Alerta, H. (2021). Comparative literary pedagogy in Philippine classrooms. International Journal of English and Comparative Literary Studies, 2(6), 14–31. https://doi.org/10.47631/ijecls.v2i6.353
5. Aulia, E. T., & Prahmana, R. C. I. (2022). Interactive e-module development using realistic mathematics education. Jurnal Elemen, 8(1), 231–249. https://doi.org/10.29408/jel.v8i1.4569

6. Azima, N. F., et al. (2025). Validity of children's storybooks for learning innovation. In Proceedings of the 5th International Conference on Education for All. Springer. https://doi.org/10.2991/978-2-38476-386-3_22
7. Barrot, J. S. (2023). K to 12 curriculum reform in the Philippines. Asia Pacific Journal of Education, 43(4), 1193–1207. https://doi.org/10.1080/02188791.2021.1973959
8. Bautista, A. M. K. (2024). Education for sustainable development in the Philippines. Doctoral dissertation, University of Tokyo.
9. Belda-Medina, J., & Goddard, M. (2024). AI-driven storytelling in EFL education. International Journal of Linguistics Studies, 4(1), 40–49. https://doi.org/10.32996/ijls.2024.4.1.4
10. Bhandari, A. (2025). Learning science in secondary classrooms: A narrative inquiry. Doctoral dissertation, Kathmandu University.
11. Cabural, A. B. (2024). PISA science performance in the Philippines. Journal of Tertiary Education and Learning, 2(3), 46–57. https://doi.org/10.54536/jtel.v2i3.3063
12. Caraig, R., & Quimbo, M. A. (2022). Science reading comprehension difficulties. International Journal of Curriculum and Instruction, 14(3), 1983–2010.
13. Chen, Z. H., & Liu, W. Y. (2021). Story structure learning approach. Computer Assisted Language Learning, 34(1–2), 184–207. https://doi.org/10.1080/09588221.2019.1688354
14. Collins, S., Steele, T., & Nelson, M. (2023). Storytelling in chemistry education. Journal of Chemical Education, 100(7), 2664–2672. https://doi.org/10.1021/acs.jchemed.3c00008
15. Cordes, A. K., Egert, F., & Hartig, F. (2023). Digital storybook interventions in education. Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie, 55(4), 155–168. https://doi.org/10.1026/0049-8637/a000264
16. Dahlstrom, M. F. (2021). Narrative truth in science communication. Proceedings of the National Academy of Sciences, 118(15), e1914085117. https://doi.org/10.1073/pnas.1914085117
17. Dai, Y., Lin, Z., Liu, A., & Wang, W. (2024). AI pedagogy in education. British Journal of Educational Technology, 55(1), 417–434. https://doi.org/10.1111/bjet.13371
18. Dewi, N. P. A., et al. (2024). Interactive teaching materials and student learning. Jurnal Ilmiah Pendidikan dan Pembelajaran, 8(3), 492–499.
19. Dizon, A. R. (2025). Filipino language and science comprehension. SSRN. https://ssrn.com/abstract=5283263
20. Engelhardt, P. V., & Beichner, R. J. (2004). Students' understanding of electric circuits. American Journal of Physics, 72(1), 98–115.
21. Fiya, F. U., & Anisah, Z. (2024). Storytelling in primary education. Giyat: Education Science, 1(2), 1–13.
22. Freitas, C. (2024). Narrative integration in engineering education. ASEE Conference Proceedings. https://doi.org/10.18260/1-2--45628
23. Höttecke, D., & Allchin, D. (2020). Nature of science education. Science Education, 104(4), 641–666. https://doi.org/10.1002/sce.21575
24. Ijiga, O. M., Ifenatuora, G. P., & Olateju, M. (2021). Digital storytelling in STEM education. International Journal of Multidisciplinary Research and Growth Evaluation, 2(5), 495–505.
25. Kim, J. S., et al. (2021). Literacy intervention in science education. Journal of Educational Psychology, 113(1), 3–18. https://doi.org/10.1037/edu0000465
26. Liao, K. C., et al. (2021). Narrative medicine in education. BMC Medical Education, 21, 321. https://doi.org/10.1186/s12909-021-02741-5
27. Li, R. Y., & Sun, J. C. Y. (2024). VR instructional design in education. Interactive Learning Environments, 32(10), 6984–6996.
28. Liu, X., Liu, C. H., & Li, Y. (2020). Dual coding theory in learning. Symmetry, 12(5), 701. https://doi.org/10.3390/sym12050701
29. Maravilla, R. A., & Aliazas, J. V. (2024). Contextualized science instructional materials. International Journal of Scientific Advances in Research and Technology, 10(2), 11–28.
30. Mayer, R. E. (2020). Multimedia learning. Cambridge University Press.
31. Ochieng, P. (2025). ADDIE model in instructional design. Journal of the Kenya National Commission for UNESCO.

32. Pacheco-Velazquez, E., et al. (2024). Game-based learning and self-directed learning. Journal of International Education in Business, 17(3), 416–430.
33. Pingil, N. P. (2022). Development of instructional modules. Psychology and Education: A Multidisciplinary Journal, 3(9), 1–11.
34. Ramezani, S. G., & Mostafavi, Z. S. (2025). E-learning quality assurance framework. Education and Information Technologies.
35. Reyes, R. L., & Villanueva, J. A. (2024). Narrative-based concept learning in chemistry. Journal of Chemical Education, 101(3), 1106–1119. https://doi.org/10.1021/acs.jchemed.3c01151
36. Rose, M. S., & Johnson, M. (2025). Storytelling for conceptual change. Journal of Educational Research and Practice, 15(1), Article 8. https://doi.org/10.5590/JSBHS.2025.19.1635
37. Saleem, A., et al. (2021). Social constructivism in education. Perennial Journal of History, 2(2), 403–421.
38. Sari, A. R., et al. (2024). Contextual teaching and learning approach. Lensa: Jurnal Kependidikan Fisika, 12(2), 197–211.
39. Shakeel, S. I., et al. (2023). ADDIE model in blended learning. Education and Information Technologies, 28(6), 7601–7630. https://doi.org/10.1007/s10639-022-11471-0
40. Snell, K., & Helén, I. (2020). Narrative meaning-making in learning. Sociology of Health and Illness, 42(3), 496–509. https://doi.org/10.1111/1467-9566.13018
41. Spatioti, A. G., et al. (2022). Instructional design model comparison. Information, 13(9), 402. https://doi.org/10.3390/info1309042
42. Sulisworo, D., et al. (2024). Cognitive load theory in VR learning. JOIV: International Journal on Informatics Visualization, 8(2), 874–881.
43. Tran, K. Q., & Selcen Guzey, S. (2023). Narrative inquiry in STEM education. Science Education, 107(6), 1507–1530. https://doi.org/10.1002/sce.21813
44. Zhu, M., Bonk, C. J., & Doo, M. Y. (2020). Self-directed learning in MOOCs. Educational Technology Research and Development, 68(5), 2073–2093. https://doi.org/10.1007/s11423-020-09747-8