Effectiveness of Multimedia-Based Instruction in Elementary Education: A Meta-Analytic Review Toward a Teaching Primer

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INTRODUCTION

Background of the Study

Education in the 21st century has been shaped by rapid technological changes that influenced how teaching and learning take place. One of the most important developments in this area was the use of multimedia, which combines text, images, audio, video, and interactive elements to support learning. Multimedia helped learners understand lessons more clearly because information was presented in different forms. Its use also supported the goals of Sustainable Development Goal 4 (SDG 4), which focused on providing inclusive and quality education for all. Organizations such as UNESCO (2024) and UNICEF (2024) emphasized that digital tools, including multimedia, played an important role in improving learning experiences and addressing the needs of diverse learners, especially in developing countries. These points showed that multimedia was not only a teaching strategy but also an important tool in improving education systems worldwide.

At the global level, many countries had already integrated multimedia into their education systems to improve student learning. Studies showed that learners understood lessons better when information was presented through both words and visuals (Mayer, 2024). Multimedia was also found to increase student motivation and academic performance (Polat, Taş, & Yıldırım, 2025; Ryan et al., 2022; Wigfield et al., 2021). However, not all countries experienced these benefits equally. Many schools still faced problems such as limited access to technology, poor internet connection, and lack of digital resources. The COVID-19 pandemic highlighted these issues, as many learners were unable to continue their education due to lack of access to digital tools (UNICEF, 2025). This situation showed that while multimedia was effective, its use remained unequal across different parts of the world.

In the Philippines, similar challenges were observed. Results from the Programme for International Student Assessment (OECD, 2024) showed that Filipino learners performed below the global average in reading, mathematics, and science. These findings indicated the need for more effective and engaging teaching strategies. Some local studies reported that multimedia improved student engagement (Almacen & Labitad, 2024), increased academic performance (Palacol, 2022), and supported early literacy development (Sibulo, 2025). However, other studies found that the effectiveness of multimedia depended on how it was designed and used in teaching (Torrington & Bower, 2021; Hall, 2024).

At the local and classroom level, teachers experienced difficulties in using multimedia effectively. Although many multimedia tools were available, there was limited guidance on how to select and use them based on learners' developmental levels and learning needs. This created a gap between the potential of multimedia and its actual use in the classroom. As a result, multimedia was not always used in a way that fully supported learning.

Although many studies had already shown that multimedia could improve learning, several gaps remained. It was already known that multimedia increased engagement and academic performance (Mayer, 2024; Polat et al., 2025; Cruz et al., 2023). However, it was still unclear which multimedia tools were most appropriate for different stages of elementary learners, since many studies focused only on one tool or one subject area (Ahmada

& Hilmiah, 2021; Torrington & Bower, 2021). In addition, some studies used small sample sizes and weak research designs, which limited the reliability of their findings (Nuqui, 2021; Hall, 2024). There was also limited research that examined multimedia from a sociocultural perspective, particularly how it supported interaction, collaboration, and guided learning (Waluyo & Apridayani, 2021; Aryfien et al., 2025). Furthermore, many studies were conducted in developed countries, which made it difficult to apply the findings to the Philippine context.

Given these gaps, this study was conducted to examine the effects of multimedia on learners and to identify appropriate multimedia tools for different stages of elementary education. The study was guided by Sociocultural Learning Theory and the Cognitive Theory of Multimedia Learning. It also aimed to synthesize existing research findings and develop a teaching primer to guide teachers in using multimedia effectively. Through this, the study intended to improve learner engagement, support academic achievement, and contribute to the goal of providing quality education for all.

THEORETICAL FRAMEWORK

This study was anchored on two complementary theoretical perspectives: Lev Vygotsky's Sociocultural Theory of Learning (SCT) and Richard E. Mayer's Cognitive Theory of Multimedia Learning (CTML). These theories provided a strong foundation for understanding how multimedia influenced learning, both from social and cognitive perspectives. Together, they explained how learners interact with multimedia tools and how these tools support knowledge construction across different developmental stages.

The Sociocultural Theory of Learning, developed by Vygotsky (1978), explains that learning occurs through social interaction and the use of cultural tools. According to this theory, knowledge is first developed through interaction with others, such as teachers and peers, before it becomes internalized by the learner. A key concept in this theory is the Zone of Proximal Development (ZPD), which refers to the gap between what a learner can do independently and what they can achieve with guidance. Learning becomes more effective when support, or scaffolding, is provided within this zone (Wood, Bruner, & Ross, 1976). In the context of this study, multimedia tools such as videos, animations, and interactive materials were viewed as cultural tools that support learning by providing guidance, visual representation, and opportunities for interaction.

This theory supported the first Statement of the Problem, which examined the effects of multimedia on learners in relation to sociocultural aspects such as interaction, collaboration, and guided learning. It also supported the second problem by explaining how different multimedia tools may be appropriate for learners at different developmental stages. Since SCT emphasizes that learning is influenced by social context and developmental level, it helped justify the need to identify appropriate multimedia tools for specific groups of learners.

The Cognitive Theory of Multimedia Learning, proposed by Mayer (2024), explains how learners process information when it is presented through multimedia. Mayer defined multimedia learning as learning from words and pictures. The theory is based on three main assumptions: the dual-channel assumption, which states that people process visual and auditory information separately; the limited capacity assumption, which suggests that each channel can only handle a limited amount of information at a time; and the active processing assumption, which states that learners actively build knowledge by connecting new information with what they already know.

Mayer (2024) also introduced several principles for effective multimedia design, such as the coherence principle, signaling principle, and redundancy principle. These principles explain how multimedia materials should be designed to support learning and avoid cognitive overload. In this study, CTML helped explain why multimedia can improve learning when it is properly designed and why it may not be effective when poorly implemented. This theory supported the first Statement of the Problem by explaining how multimedia affects learners' understanding and retention. It also supported the second and third problems by helping identify appropriate multimedia tools and explaining the limitations found in previous studies, particularly those related to design and cognitive overload.

Both theories also provided a basis for analyzing the limitations of existing studies, as required in the third Statement of the Problem. While SCT highlighted the importance of social interaction and context, CTML

emphasized the need for proper design and cognitive alignment. These perspectives helped explain why some studies reported positive results while others showed limited effectiveness.

The integration of Sociocultural Theory and the Cognitive Theory of Multimedia Learning provided a comprehensive framework for this study. SCT explained how multimedia functioned as a tool for social interaction, scaffolding, and development, while CTML explained how learners processed and understood multimedia content. Together, these theories guided the analysis of the effects of multimedia, the identification of appropriate tools for different developmental stages, and the evaluation of limitations in existing studies. Furthermore, they provided a strong foundation for the development of an evidence-based teaching primer, which addressed the fourth Statement of the Problem. Through this integrated framework, the study was able to systematically examine multimedia in education and provide meaningful and research-based recommendations for teaching practice.

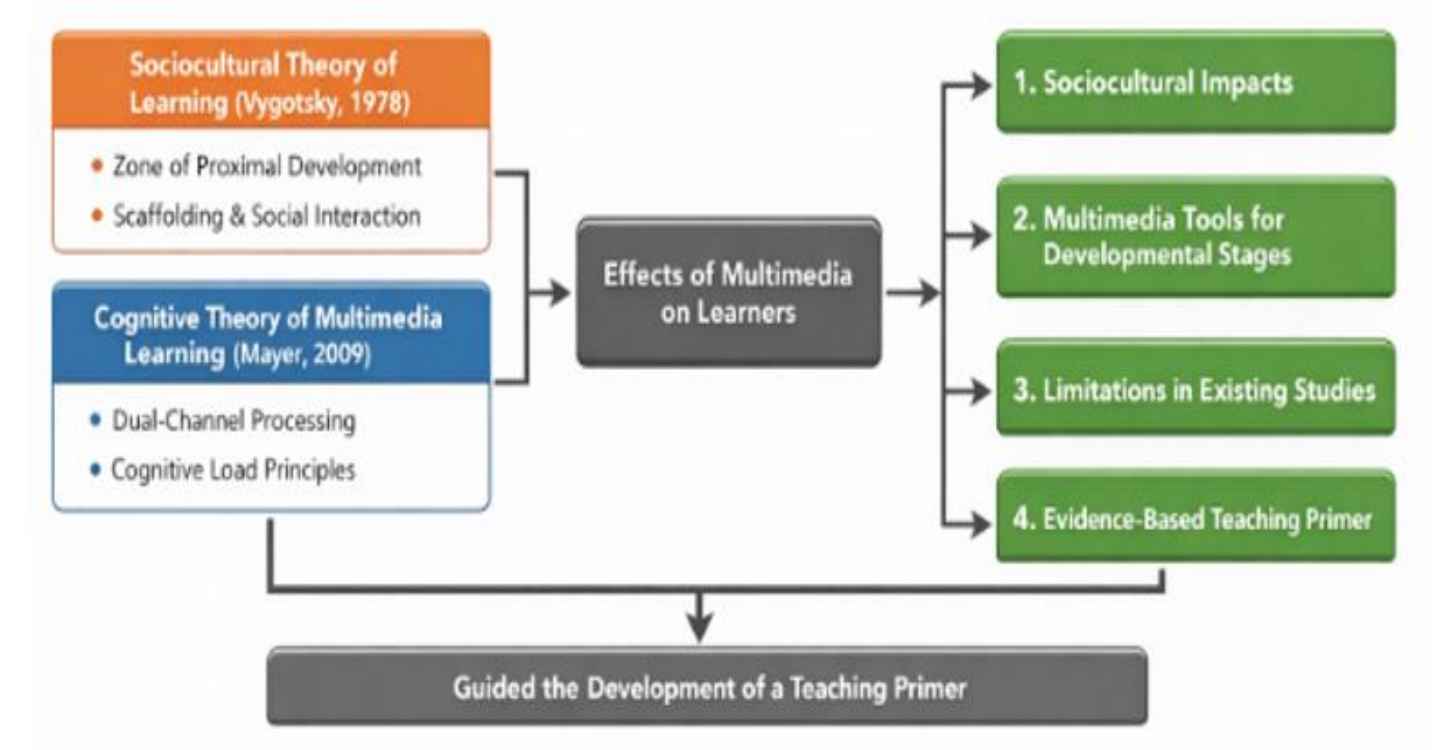

Figure 1. The Research Paradigm

This study utilized a conceptual framework to provide a clear and organized structure for examining how theoretical foundations and research insights informed the development of a teaching primer on multimedia use. The framework was employed to ensure that the study was grounded in established learning theories while systematically linking these theories to the analysis of multimedia's effects on learners and the formulation of practical educational outputs.

The input of the framework consisted of two primary theoretical foundations. These included the Sociocultural Theory of Learning proposed by Lev Vygotsky and the Cognitive Theory of Multimedia Learning developed by Richard E. Mayer. Vygotsky's theory contributed key concepts such as the Zone of Proximal Development (ZPD) and the importance of scaffolding and social interaction, emphasizing that learning occurred through guided participation and collaboration. Meanwhile, Mayer's theory provided principles related to dual-channel processing and cognitive load, explaining how learners processed multimedia information and how instructional materials should be designed to avoid cognitive overload. These theoretical inputs established the lens through which multimedia's role in learning was examined.

The process component of the framework was represented by the central focus on the "Effects of Multimedia on Learners," which served as the point of integration between theory and analysis. Through this process, the study examined how multimedia influenced learning outcomes by considering both sociocultural and cognitive dimensions. The framework further organized this analysis into four key areas: sociocultural impacts, which

explored how multimedia affected interaction and collaboration; multimedia tools for developmental stages, which considered the appropriateness of tools based on learners' cognitive readiness; limitations in existing studies, which identified gaps and inconsistencies in prior research; and the synthesis of these findings into an evidence-based perspective. This process demonstrated a structured approach to interpreting data and linking theoretical principles to observed educational outcomes.

The output of the framework was the development of an evidence-based teaching primer. This primer was informed by the combined insights of theory and analyzed research findings, ensuring that recommendations were both pedagogically sound and empirically supported. It translated abstract concepts into practical strategies for classroom implementation, particularly in the effective use of multimedia tools. Overall, the framework showed that the integration of sociocultural and cognitive theories, together with systematic analysis, resulted in a comprehensive and research-grounded instructional resource.

REVIEW OF RELATED LITERATURE

This section presents the reviewed literature organized according to the four Statements of the Problem (SOPs) of the study. Each theme discusses relevant studies, followed by a synthesis highlighting similarities, differences, and research gaps that justify the need for this study.

Effects of Multimedia on Learners in Relation to Sociocultural Learning Theory

Multimedia has become a significant instructional tool in facilitating learning, particularly when viewed through the lens of sociocultural learning theory, which emphasizes interaction, scaffolding, and the use of mediational tools in knowledge construction. This theme explores how multimedia influences learners' engagement, motivation, and academic performance while supporting social and cognitive processes.

Cruz et al. (2023) examined the use of video clip presentations in teaching Creative Nonfiction among Grade 11 students. The study used a quasi-experimental design and found that students exposed to video-based instruction achieved higher academic performance compared to those using modular materials. The authors explained that video clips acted as scaffolding tools that supported learners' understanding and engagement.

Tran Thien (2022) investigated the use of YouTube video clips in improving English listening comprehension. Using a pretest–posttest design, the study found that multimedia exposure improved both comprehension and learner attitudes. The study emphasized that audiovisual materials helped learners process authentic language in meaningful contexts.

Nuqui (2021) explored the effectiveness of audio-video lessons in improving English performance among Grade 3 learners. The findings showed significant improvement after multimedia exposure, suggesting that audiovisual materials provided contextualized input that enhanced understanding.

Husna and Bentri (2025) studied the integration of learning videos in mathematics instruction. Their quasi-experimental study revealed increased engagement and improved academic performance, highlighting the role of multimedia in visualizing abstract concepts.

Ahmada and Hilmiah (2021) examined the use of video clips in improving writing skills among English learners. The results showed improved writing performance, as multimedia supported idea organization through visual storytelling.

Papuanga, Notanubun, and Ririhena (2025) used audiovisual media in teaching short story writing. Their classroom action research showed consistent improvement in student performance, indicating that repeated multimedia exposure supported skill development.

Parraga Lino and Tomala Chavez (2025) explored the use of cartoon videos in listening instruction. The study found increased comprehension and motivation, suggesting that animated multimedia made learning more engaging for young learners.

Almacen and Labitad (2024) examined teachers' perceptions of multimedia integration. Teachers reported that multimedia improved interaction and motivation, although challenges such as limited resources were noted.

Waluyo and Apridayani (2021) studied teachers' beliefs and practices regarding video use. While teachers showed positive attitudes, actual use was limited due to lack of training and technological constraints.

Hall (2024) investigated the motivational effects of video lessons. The study found increased motivation but noted that this did not always lead to improved academic performance.

The reviewed studies consistently demonstrated that multimedia enhances learners' engagement, motivation, and academic performance (Cruz et al., 2023; Tran Thien, 2022; Nuqui, 2021; Husna & Bentri, 2025; Ahmada & Hilmiah, 2021; Papuanga et al., 2025; Parraga Lino & Tomala Chavez, 2025). These findings support the sociocultural perspective that multimedia serves as a mediational tool that facilitates scaffolding, interaction, and meaning-making in the learning process (Almacen & Labitad, 2024; Waluyo & Apridayani, 2021).

However, variations in outcomes were observed, as some studies reported improvements in academic performance while others identified increases only in motivation without corresponding achievement gains (Hall, 2024). Moreover, most studies focused on measuring outcomes rather than explaining how sociocultural processes such as interaction, collaboration, and scaffolding actually occur in multimedia-supported environments (Cruz et al., 2023; Tran Thien, 2022; Husna & Bentri, 2025). There is also limited research conducted in developing contexts, where access to multimedia resources may influence results (Almacen & Labitad, 2024; Waluyo & Apridayani, 2021).

These gaps indicate the need for a more systematic and theory-driven analysis that not only measures the effects of multimedia but also explains the underlying sociocultural mechanisms involved (Hall, 2024; Waluyo & Apridayani, 2021). This justifies the present study.

Multimedia Tools Appropriate for Different Developmental Stages

The effectiveness of multimedia in education is influenced by the developmental stage of learners. Different types of multimedia tools are suited to varying cognitive abilities, learning preferences, and levels of independence. This theme examines how multimedia tools align with learners' developmental needs from early childhood to intermediate levels.

Sibulo (2025) conducted a developmental study that designed and implemented audiovisual instructional materials for kindergarten learners. The study used an experimental approach to measure reading readiness before and after exposure to multimedia materials. Findings revealed significant improvement in learners' phonological awareness and letter recognition. The study concluded that audiovisual materials are effective for early learners because they support sensory-based and visual learning.

Miranda (2025) employed a quasi-experimental research design to examine the effectiveness of PowerPoint-based multimedia presentations among preschool learners. Using pretest and posttest measures, the study found that learners demonstrated improved letter recognition skills after exposure to animated and visual presentations. The findings highlighted that simple visual and animated multimedia can effectively support early literacy development.

Zhang (2024) used an experimental design to investigate culturally relevant multimedia materials for preschool learners. The study integrated multimedia content reflecting learners' cultural background and assessed cognitive development outcomes. Results showed improved conceptual understanding and cognitive development. The study emphasized that culturally appropriate multimedia enhances learning by making content more meaningful to learners.

Rahmah (2025) applied a quasi-experimental design to evaluate the effectiveness of interactive game-based media for early numeracy skills among young children. The study used pretest and posttest assessments and found that learners exposed to game-based multimedia showed significant improvement in mathematical

reasoning. The findings suggested that interactive and play-based multimedia supports active learning among early learners.

Herman et al. (2025) conducted an experimental study on augmented reality (AR) storytelling among young learners. The study compared traditional storytelling with AR-based storytelling and found that learners exposed to AR showed higher engagement and better social interaction. The study concluded that immersive multimedia enhances both cognitive and social learning experiences.

Pujiariani and Cathrin (2025) utilized a quasi-experimental design to examine interactive multimedia in improving reading skills among Grade 1 learners in remote schools. The study found that students who used interactive multimedia performed better in reading assessments compared to those who used traditional methods. The findings highlighted the importance of multimedia in supporting learning in resource-limited settings.

Turmudli, Sumarno, and Buchori (2025) conducted a developmental research study to design and validate visual literacy-based multimedia for Grade 2 learners. The study involved expert validation and field testing. Results showed that the multimedia materials were effective in improving learners' writing skills, particularly in organizing ideas and constructing sentences.

Oktania et al. (2025) used an experimental research design to investigate the effectiveness of interactive learning games in science instruction for Grade 2 learners. The study found that students exposed to interactive games demonstrated higher motivation and improved academic performance. The results indicated that game-based multimedia enhances both engagement and learning outcomes.

Jalmasco et al. (2025) developed and tested a digital storytelling platform for Grade 6 learners using a quasi-experimental design. The findings showed that students who used the platform had improved engagement and better understanding of ecological concepts. The study emphasized that multimedia supports higher-order thinking among older learners.

Alyusfitri et al. (2024) conducted an experimental study on multimedia-based e-modules for Grade 5 learners. The study found that learners exposed to interactive modules achieved higher academic performance compared to those using traditional materials. The results suggested that structured multimedia supports independent learning.

Yonanda et al. (2024) used a quasi-experimental design to evaluate interactive multimedia materials among Grade 5 learners. The findings showed increased motivation and improved learning outcomes, indicating that interactive multimedia is effective for intermediate learners.

The reviewed studies consistently showed that multimedia tools must be aligned with learners' developmental stages to maximize effectiveness (Sibulo, 2025; Miranda, 2025; Zhang, 2024; Rahmah, 2025; Herman et al., 2025). For early learners, audiovisual materials, animations, and game-based media were found to support sensory engagement and play-based learning. For lower elementary learners, interactive storytelling and visual literacy materials enhanced foundational skills and engagement (Pujiariani & Cathrin, 2025; Turmudli et al., 2025; Oktania et al., 2025). For intermediate learners, more complex multimedia tools such as digital platforms and e-modules supported higher-order thinking, independent learning, and deeper understanding (Jalmasco et al., 2025; Alyusfitri et al., 2024; Yonanda et al., 2024).

Despite these consistent findings, several limitations were identified. Most studies focused on a single type of multimedia tool and a specific grade level, making cross-developmental comparisons difficult (Sibulo, 2025; Miranda, 2025; Rahmah, 2025). There is also a lack of a unified framework that clearly categorizes which multimedia tools are most appropriate for each developmental stage (Zhang, 2024; Herman et al., 2025). Furthermore, few studies integrated both cognitive and sociocultural perspectives in selecting and evaluating multimedia tools (Alyusfitri et al., 2024; Yonanda et al., 2024).

These gaps highlight the need for a comprehensive synthesis that systematically compares multimedia tools across developmental stages and provides structured, evidence-based recommendations (Pujiariani & Cathrin,

2025; Turmudli et al., 2025). This justifies the present study, particularly in developing a teaching primer aligned with learners' developmental needs.

Common Limitations in Multimedia Studies

While many studies highlight the positive effects of multimedia in education, it is equally important to examine the methodological and contextual limitations that may affect the validity and applicability of these findings. This theme focuses on identifying common weaknesses across multimedia research.

Torrington and Bower (2021) conducted an experimental study that examined the effectiveness of multimedia-based instruction in mathematics. The study involved a limited number of participants drawn from a single class. While the findings indicated improvement in learners' understanding and performance, the researchers acknowledged that the small sample size restricted the generalizability of the results. This limitation made it difficult to apply the findings to a broader population.

Ahmada and Hilmiah (2021) used a pre-experimental research design to investigate the effect of video clips on students' writing performance. The study employed a one-group pretest–posttest design without a control group. Although the results showed improvement in writing skills after the intervention, the absence of a comparison group limited the ability to establish a clear cause-and-effect relationship. The authors noted that other factors may have influenced the results.

Nuqui (2021) conducted a quasi-experimental study that examined the use of audio-video lessons in improving English performance among Grade 3 learners. The study used a single group and measured performance over a short period. While the findings indicated significant improvement, the researcher acknowledged that the use of only one group and the limited duration of the study reduced the strength of the conclusions and did not allow for long-term evaluation.

Santos (2025) implemented an experimental study on multimedia-based reading instruction among elementary learners. The intervention was conducted over a short period, and results showed improvement in reading performance. However, the study identified that the short duration of implementation limited the ability to determine whether the effects of multimedia were sustained over time. The researcher suggested that longer-term studies are needed.

Pujiariani and Cathrin (2025) conducted a quasi-experimental study that examined the effectiveness of interactive multimedia in improving reading skills among learners in remote schools. While the results showed improved academic performance, the study highlighted significant challenges related to limited access to digital devices and unstable internet connectivity. These technological constraints affected the implementation and consistency of multimedia use.

Waluyo and Apridayani (2021) used a qualitative research design to explore teachers' beliefs and practices regarding the use of multimedia in English language teaching. The findings revealed that although teachers expressed positive attitudes toward multimedia, many did not fully implement it in their classrooms. The study identified lack of training, limited technical skills, and insufficient institutional support as key barriers to effective multimedia integration.

The reviewed studies revealed recurring methodological limitations, including small sample sizes, single-group designs, and short intervention durations, which reduce the reliability and generalizability of findings (Torrington & Bower, 2021; Ahmada & Hilmiah, 2021; Nuqui, 2021; Santos, 2025). While positive outcomes were frequently reported, these research designs limit the ability to establish strong causal relationships and assess long-term effects of multimedia on learning.

In addition to methodological concerns, contextual limitations were also evident. Challenges such as limited access to technology, unstable internet connectivity, and lack of teacher training significantly affected the implementation of multimedia (Pujiariani & Cathrin, 2025; Waluyo & Apridayani, 2021). Furthermore, a gap was observed between teachers' positive perceptions of multimedia and their actual classroom practices.

These gaps indicate the need for more rigorous and comprehensive research designs, including larger sample sizes, control groups, and longitudinal approaches (Torrington & Bower, 2021; Santos, 2025). There is also a need to address contextual challenges by providing adequate technological resources and teacher training (Waluyo & Apridayani, 2021; Pujiariani & Cathrin, 2025). These limitations justify the need for a systematic and critical synthesis in the present study.

Evidence-Based Foundations for a Teaching Primer

The development of an effective teaching primer requires a strong theoretical and empirical foundation. This theme examines key theories and evidence-based studies that inform the design, implementation, and effectiveness of multimedia instruction.

Mayer (2024) developed the Cognitive Theory of Multimedia Learning through a series of experimental studies that examined how learners process information presented through words and pictures. Using controlled laboratory experiments, Mayer identified key multimedia design principles such as coherence, signaling, redundancy, and contiguity. The findings showed that learners understand and retain information better when multimedia materials are carefully designed to reduce cognitive overload. This work provides a strong theoretical and empirical foundation for designing effective multimedia instructional materials.

Aligo and Prudente (2025) conducted a meta-analysis of studies on digital learning materials to determine the overall effectiveness of multimedia in education. The study synthesized results from multiple empirical studies and calculated effect sizes. Findings revealed that multimedia instruction is most effective when it integrates multisensory elements and promotes active and interactive learning. The authors emphasized that combining visual, auditory, and interactive components leads to better learning outcomes compared to single-mode instruction.

May, Strong, and Walpole (2024) employed a mixed-methods research design to examine the role of teacher training in multimedia integration. The study involved classroom observations, surveys, and performance assessments. Results showed that teachers who received structured training were more effective in using multimedia tools, leading to improved student engagement and learning outcomes. The study highlighted that teacher preparedness is a critical factor in the successful implementation of multimedia instruction.

Villena-Taranilla et al. (2022) conducted a meta-analysis on the use of immersive multimedia, particularly virtual reality (VR), in education. The study analyzed multiple experimental studies and found that immersive technologies significantly improved student engagement and conceptual understanding. The authors explained that immersive environments allow learners to experience content in a more interactive and meaningful way, which enhances learning.

Furenes, Kucirkova, and Bus (2021) conducted a comparative experimental study that examined the effects of digital picture books versus traditional print books on children's comprehension. The findings showed that interactive digital books improved comprehension when designed with appropriate features such as guided narration and interactive prompts. However, the study also noted that poorly designed interactive features could distract learners and reduce learning effectiveness.

The reviewed literature provided strong evidence that effective multimedia integration depends on both sound design principles and appropriate implementation strategies (Mayer, 2024; Aligo & Prudente, 2025). Cognitive principles such as coherence, signaling, and contiguity were shown to enhance learning by reducing cognitive overload, while interactive and immersive multimedia were found to improve engagement and conceptual understanding (Villena-Taranilla et al., 2022).

Additionally, teacher-related factors play a crucial role, as studies showed that trained teachers are more effective in integrating multimedia into instruction (May et al., 2024). The quality of multimedia design was also identified as a critical factor influencing learning outcomes, particularly in the use of digital and interactive materials (Furenes et al., 2021).

Despite these contributions, several gaps remain. Most studies focused on specific tools or strategies without integrating them into a comprehensive instructional framework (Aligo & Prudente, 2025; Villena-Taranilla et al., 2022). There is a lack of consolidated resources that translate theoretical principles into practical classroom applications (Mayer, 2024; Furenes et al., 2021). Furthermore, limited studies combined both cognitive and sociocultural perspectives in designing multimedia instruction (May et al., 2024; Aligo & Prudente, 2025).

These gaps highlight the need for a structured and evidence-based teaching primer that integrates multimedia design principles, appropriate tools, and practical strategies (Mayer, 2024; May et al., 2024). This justifies the development of the teaching primer in the present study.

Across all themes, the literature consistently showed that multimedia positively influences learning by improving engagement, motivation, and understanding. It supports both cognitive processing and interactive learning experiences. However, several critical gaps remain.

There is limited integration of sociocultural and cognitive perspectives (Mayer, 2024; Waluyo & Apridayani, 2021), insufficient comparison of multimedia tools across developmental stages (Sibulo, 2025; Alyusfitri et al., 2024), and methodological weaknesses that affect research validity (Torrington & Bower, 2021; Santos, 2025). Additionally, there is a lack of practical, research-based instructional guides for teachers (Aligo & Prudente, 2025; May et al., 2024).

These gaps highlight the need for a systematic review and meta-analysis that synthesizes existing research and translates findings into an evidence-based teaching primer (Mayer, 2024; Aligo & Prudente, 2025; May et al., 2024; Villena-Taranilla et al., 2022; Furenes et al., 2021; Waluyo & Apridayani, 2021; Sibulo, 2025; Alyusfitri et al., 2024; Torrington & Bower, 2021; Santos, 2025). This justifies the significance and contribution of the present study.

Statement of the Problem

This study conducted a systematic review to provide a comprehensive and rigorous synthesis of existing literature on the effects of multimedia on learners. The study aimed to generate evidence that could support the development of a valid and effective teaching primer. Guided by Sociocultural Learning Theory, the study examined how multimedia influences learning across different developmental stages and identified existing gaps in the literature.

Specifically, this study sought to answer the following questions:

1. What is the overall distribution of effect size regarding the impact of multimedia-interpreted instruction on learner engagement and retention?

2. What are the effects of multimedia on learners, particularly in relation to the key areas of Sociocultural Learning Theory?

3. What multimedia tools are relevant and appropriate for different developmental stages?

4. What common limitations are identified in existing studies on multimedia in education?

5. What evidence-based teaching primer can be developed based on the findings of the study?

Importance of the Study

This study is significant as it provides empirical evidence on the role of multimedia in modern pedagogy, offering a clear roadmap for enhancing student outcomes. The findings are particularly valuable to the following:

For Students. It could identify the specific types of digital engagement that foster higher intrinsic motivation and academic success, ensuring that the technology used in their classrooms directly supports their unique learning styles and cognitive development.

For Teachers. This research could serve as a practical guide, providing them with a validated teaching primer to effectively integrate multimedia. It helps educators move beyond simple technology use toward intentional, socio-culturally mediated instruction that targets the Zone Proximal of Development.

For School Administrators. The study could provide a data-driven basis for curriculum planning and resource allocation, justifying investments in ICT infrastructure and professional development programs that prioritize interactive learning environments.

For Curriculum Developers. It could offer insights into how instructional materials can be designed to be more inclusive and developmentally appropriate, ensuring that digital content aligns with both global standards and local educational contexts.

For Researchers and Academics. This study could identify critical gaps in the existing literature on multimedia education, pointing to the urgent need for longitudinal, experimental, and culturally grounded research designs that can produce more robust causal evidence. It further contributes to the theoretical discourse by demonstrating how Vygotsky's Sociocultural Theory remains a relevant and productive lens for analyzing digital learning tools in contemporary educational contexts

Policymakers and the Department of Education in the Philippines. This study could offer evidence that aligns with national priorities such as SDG 4 and the vision for inclusive, technology-enhanced education. By identifying both the potential and the limitations of multimedia in elementary classrooms, this study supports more informed, equity-driven, and evidence-based educational policy development that addresses the unique challenges of Filipino learners and their communities.

METHODOLOGY

This chapter presents the methodological framework of the study, including research design, sources of data, data gathering procedures, methods of analysis, and ethical considerations. It provides a systematic and comprehensive description of how the meta-analysis was conducted to ensure the credibility, transparency, validity, and quantitative rigor of the synthesized findings.

Research Design

This study used a meta-analysis of quantitative studies as its research design. Meta-analysis is a method that combines and analyzes the results of several independent studies that focus on the same research topic. It uses statistical techniques to summarize findings and identify overall patterns. Compared to a narrative review, which describes results in words, meta-analysis provides a more objective and organized way of analyzing data (Glass, 1977; Borenstein et al., 2021).

In this study, only quantitative research studies were selected. These studies provided measurable data, such as test scores and performance results, which allowed for comparison across different studies. By combining these results, the study was able to determine general trends in the effects of multimedia on learners.

The use of meta-analysis was appropriate because studies on multimedia in education have been conducted in different contexts and across various developmental stages. Through this design, the study was able to bring together findings from different sources and present a clearer and more consistent understanding of how multimedia affects learning.

Sources of Data

The data for this meta-analysis were drawn from published, peer-reviewed journal articles, academic theses, dissertations, and scholarly research reports that examine the use of multimedia in educational contexts. These studies were systematically retrieved from reputable international and multidisciplinary academic databases, primarily ERIC and Google Scholar, which provide access to high-quality education research.

Since this study employed a meta-analytic design, it did not involve direct interaction with human participants nor was it limited to a single geographical location. Instead, it synthesized quantitative effect size data across diverse educational settings, enabling broader generalizability, statistical comparability, and rigorous analysis of multimedia's impact on learner outcomes. This approach ensures that findings are applicable across multiple educational contexts rather than being confined to a specific locale or cohort.

To identify relevant studies, a systematic search was conducted using predefined inclusion and exclusion criteria. These criteria guided the selection, screening, and final inclusion of studies, ensuring methodological rigor and objectivity in the data collection process (Creswell, 2012; Meline, 2006).

Table 1. Inclusion and Exclusion Criteria

Parameter	Inclusion Criteria	Exclusion Criteria
Focus of the Study	Includes research articles or scientific journals that explicitly examine the effects of multimedia on learning outcomes, especially those grounded in Socio-Cultural Learning Theory.	Excludes studies that do not primarily focus on multimedia's effect on learning, or those that only mention multimedia in passing.
Time Frame	Published from 2020 to the present ensure relevance and recency.	Studies published in 2019 or earlier.
Language	Studies published in English.	Articles written in other languages not accessible to the researcher.
Database	Includes peer-reviewed research articles and journals accessible through Google Scholar and ERIC database.	Excludes sources from database not accessible via Google Scholar or ERIC.
Study Population	Includes studies involving elementary learners (Kindergarted to Intermediate) in formal or informal educational settings, where multimedia is used as an instructional tool and studies that are quantitative only.	Excludes studies focusing solely on adult learners, non-educational context, animal subjects, or those that do not assess multimedia's impact on learning or teaching outcomes.

Data Gathering Procedure

This meta-analysis followed a transparent and structured process guided by the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework and anchored in the principles of Sociocultural Learning Theory. The adoption of PRISMA ensured methodological transparency, replicability, and rigor in the identification, screening, eligibility assessment, and inclusion of quantitative studies whose statistical data could be extracted and synthesized into pooled effect size estimates.

A comprehensive literature search was conducted using keywords and Boolean operators such as multimedia and education, video-based learning, interactive digital materials, and Sociocultural Learning Theory. This initial search yielded 20,800 research articles and studies examining the effects of multimedia on learning outcomes. To ensure the timeliness and relevance of evidence, only studies published from 2020 onwards were considered, reducing the dataset to 7,080 records. Further, to maintain accessibility and comparability, only studies published in English were included, narrowing the pool to 3,270 studies.

Primary retrieval was undertaken through Google Scholar and ERIC, focusing exclusively on peer-reviewed research articles and academic journals to ensure scholarly rigor and credibility. This process refined the dataset to 131 studies deemed methodologically sound and accessible for full-text review.

Titles and abstracts of the retrieved studies were examined to determine initial relevance. Articles that did not directly investigate multimedia as an instructional tool were excluded. This phase ensured that only studies aligned with the meta-analysis focus progressed further.

Full-text evaluation was conducted using predefined inclusion and exclusion criteria. Emphasis was placed on studies involving elementary learners (Kindergarten to Intermediate levels) and the instructional use of multimedia in both formal and informal educational settings. Studies were further assessed for methodological quality and availability of quantitative data suitable for meta-analytic synthesis.

Only studies meeting all eligibility parameters were retained for synthesis. To ensure comparability and measurability of outcomes, the review was limited to quantitative research designs. This rigorous process resulted in a final corpus of 27 studies included in the systematic analysis.

This multi-stage procedure ensured a systematic, replicable, and defensible meta-analytic process aligned with the study's objectives and research questions. The stepwise selection process, illustrated in Figure 2 (PRISMA 2020 Flow Diagram), strengthened the validity and transparency of the quantitative evidence used to examine multimedia's role in learning within the framework of Sociocultural Learning Theory. Only studies providing sufficient statistical information for effect size computation were retained, ensuring a robust quantitative synthesis.

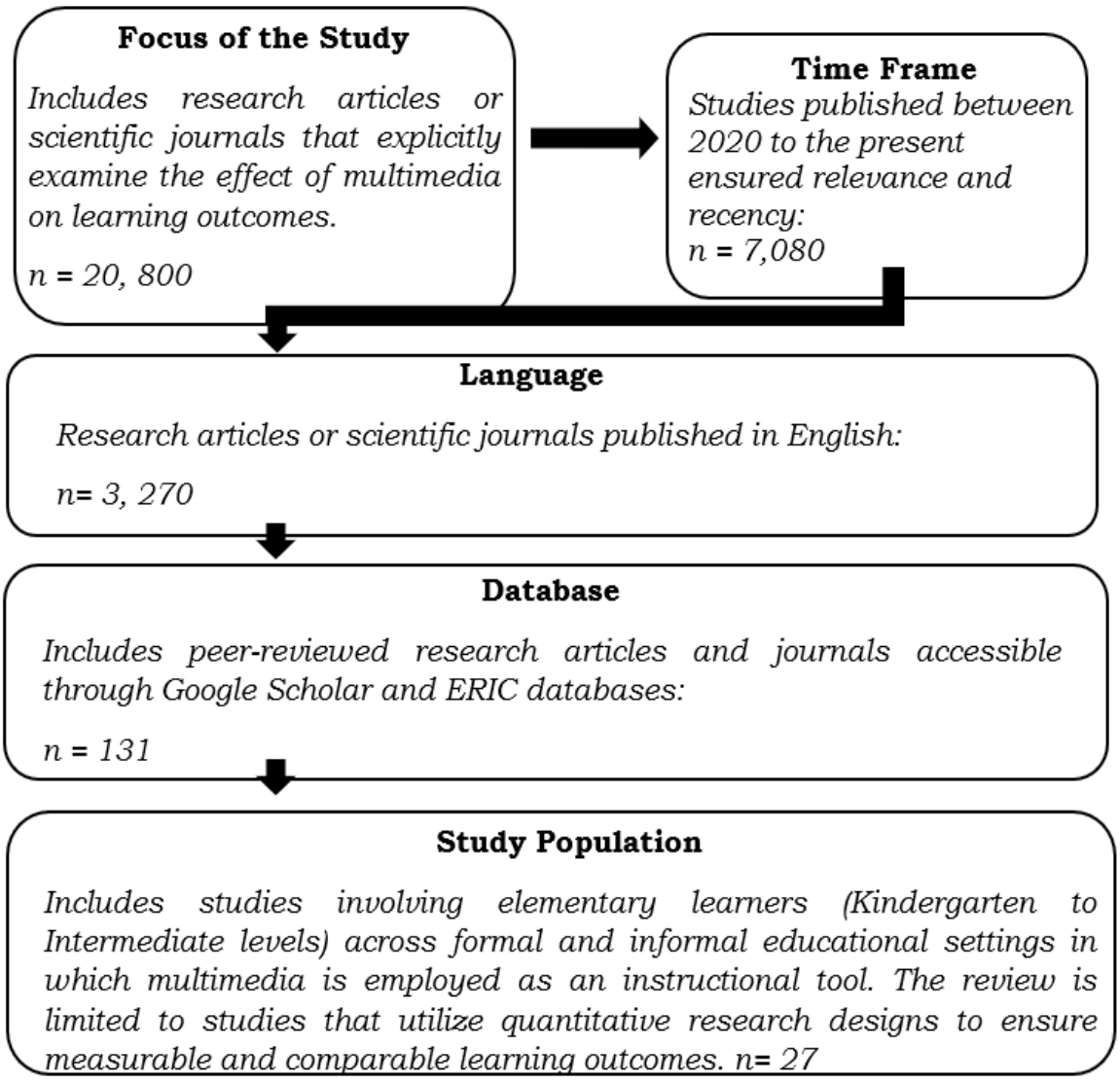

Figure 2. PRISMA (2020) Flow Diagram

Analysis of Data

Data analysis in this meta-analysis followed a quantitative descriptive synthesis approach designed to systematically organize, categorize, and interpret findings from the included studies using frequency counts and percentage distributions. This approach allowed for meaningful comparison of findings despite variations in sample sizes, research designs, measurement tools, and multimedia interventions. All selected studies employed

quantitative designs, ensuring the suitability of categorical aggregation and analysis. In addition to frequency counts and percentage distributions, this study incorporated weighted mean effect size calculations to provide a more precise estimate of the overall impact of multimedia across studies. Each study's effect size was weighted based on its sample size to ensure that studies with larger samples contributed more substantially to the pooled estimate. Confidence intervals (95%) were also computed to assess the precision and reliability of the estimated effect sizes. Furthermore, heterogeneity among studies was examined using statistical measures such as the Q statistic and I^2 index to determine the extent of variability across study findings. This allowed the study to assess whether differences in results were due to chance or underlying methodological and contextual variations.

Effect sizes were calculated using standardized mean differences (Cohen's d), derived from reported means, standard deviations, and sample sizes of experimental and control groups. In cases where direct values were unavailable, alternative statistical data such as t-values or F-values were converted into effect sizes using established formulas. The interpretation followed conventional thresholds: small (d = 0.20), moderate (d = 0.50), and large (d = 0.80), ensuring consistency in categorizing the magnitude of multimedia effects.

The analysis began with systematic data extraction, wherein full-text articles were carefully reviewed to obtain relevant information such as author and year of publication, research design, sample size, participant characteristics, educational level, types of multimedia tools used, and reported learning outcomes. Extracted data were then coded and categorized according to the Statements of the Problem (SOPs). Specifically, studies were classified based on their reported effects on learner engagement and retention, their alignment with key components of Sociocultural Learning Theory such as social interaction, scaffolding, mediation, and Zone of Proximal Development, the types of multimedia tools appropriate for different developmental stages, and the methodological and contextual limitations identified in each study.

Following the coding process, frequency counts were computed to determine how many studies corresponded to each category. These frequencies were then converted into percentages to provide a clearer representation of the distribution of findings. This enabled the identification of the most frequently reported effects of multimedia, the most supported sociocultural components, the most commonly used multimedia tools across developmental stages, and the most recurring limitations in multimedia research. The categorized data were further organized into thematic domains, including the effects of multimedia on learners, multimedia tools appropriate for developmental stages, common limitations in multimedia studies, and evidence-based foundations for teaching primer development.

Finally, the analysis involved the interpretation and synthesis of findings across all themes. Emphasis was placed on identifying consistent patterns and relationships among variables, which served as the basis for drawing conclusions and formulating evidence-based recommendations. The results of the analysis were used to inform the development of a teaching primer that translates the most relevant and frequently supported findings into practical instructional strategies aligned with both developmental needs and sociocultural learning principles. Overall, the use of frequency count and percentage distribution provided a systematic and transparent method of synthesizing research findings, ensuring that the analysis remained directly aligned with the objectives of the study and relevant to classroom application.

Ethical Consideration

This meta-analysis adhered to established principles of research ethics, including transparency, academic integrity, and methodological rigor. The processes of study identification, screening, inclusion, data extraction, and statistical analysis were clearly documented to ensure replicability and accountability.

Since the study relied exclusively on previously published literature and did not involve direct interaction with human participants, institutional ethical clearance was not required. Nevertheless, the review upheld the ethical standards observed in the original research, particularly those related to informed consent, participant confidentiality, and data protection.

All included sources were drawn from peer-reviewed academic databases, ensuring prior ethical vetting. The synthesis was conducted objectively, with deliberate efforts to represent findings accurately, avoid misinterpretation, and minimize reviewer bias.

Any potential conflicts of interest were disclosed and addressed to preserve research integrity. Through adherence to these ethical standards, the study ensured the credibility and scholarly value of its synthesized conclusions regarding multimedia's role in learning within the framework of Sociocultural Learning Theory.

FINDINGS AND DISCUSSION

The analysis of the selected studies was conducted to determine the effects of multimedia on learners, identify appropriate multimedia tools across developmental stages, examine limitations of existing studies, and develop an evidence-based teaching primer. The findings are presented according to the Statements of the Problem.

Distribution of Effect Size Regarding the Impact of Multimedia Integration

Figure 1 presents the distribution of effect sizes of multimedia studies included in this meta-analysis. A total of 27 quantitative studies were reviewed, and the computed effect sizes were categorized into small, moderate, and large effects.

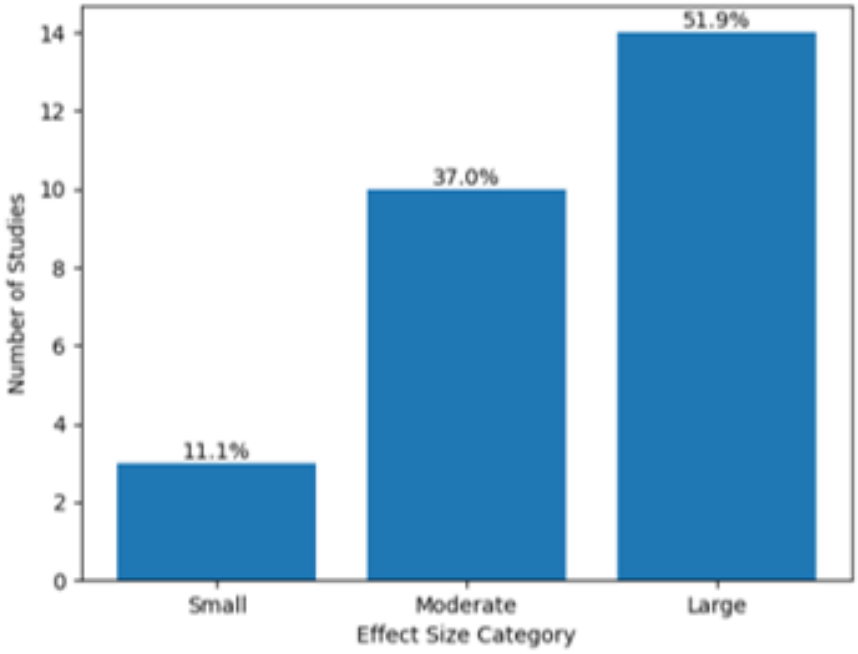

Figure 3. Effect Size Distribution of Multimedia Studies

Out of the 27 studies reviewed, 14 studies with 51.9% are reported large effect sizes, indicating that multimedia integration in instruction produced substantial improvements in learners' academic performance, engagement, and conceptual understanding. This suggests that when multimedia is effectively designed and implemented, it serves as a powerful instructional tool that enhances both cognitive and behavioral learning outcomes.

Ampuyos and Villaruz (2022) demonstrated that video-clip instruction significantly improved English performance from moderately effective to excellent. Lagua (2024) reported a shift from low to mastered understanding of weather concepts. Samosa et al. (2021) found significant improvements in writing skills through animated video stories, while Özdemir et al. (2025) showed enhanced reading comprehension using multimedia animations. Ocampo (2022) and Untong (2025) both confirmed that video-based instruction improved literacy and language learning outcomes, particularly for early and indigenous learners

Further support comes from Mohammad and Boushehry (2023), who observed improved motor skills through video-based instruction, and Febiyanti et al. (2021), who found gains in listening skills using project-based video learning. Mijares III (2023) and Yandani and Agustika (2022) emphasized the effectiveness of multimedia in enhancing conceptual understanding through combined visual and textual elements. Mohamed et al. (2025) and Samat and Aziz (2020) further showed that multimedia supports writing and reading comprehension through multi-modal scaffolding. Nurmaelinda and Jesicha (2025) reported high effectiveness (N-Gain = 0.82) in literacy

development, while Ayub and Kiazai (2021) found significant improvements in motivation and retention. Collectively, these studies confirm that multimedia consistently produces strong positive learning outcomes.

The dominance of large effect sizes which is 51.9% implies that multimedia is most effective when it is interactive, scaffolded, and aligned with instructional goals. Hsu et al. (2022) demonstrated that embedding reflective prompts in video learning significantly enhanced higher-order thinking, emphasizing the importance of active engagement. These findings support Sociocultural Theory, where multimedia acts as a mediating tool within the Zone of Proximal Development. Therefore, educators should design multimedia instruction that promotes interaction, guided learning, and meaningful engagement to sustain these strong effects.

A total of 10 studies with 37.0% are reported moderate effect sizes, indicating that multimedia produced noticeable but not maximal improvements in learning outcomes. This suggests that while multimedia is beneficial, its effectiveness is influenced by factors such as instructional design, implementation quality, and learner engagement.

Several studies in the repertory grid reflect this moderate impact. Koto (2020) found that YouTube videos improved procedural knowledge but had limited effects on conceptual and factual knowledge. Irwam (2020) similarly reported varied effects, with no clear advantage of video-assisted learning over traditional methods. Alyusfitri et al. (2024) showed only “quite effective” results (N-Gain = 0.51) in geometry learning.

Baltzaki and Chlapana (2023) found that while ICT improved vocabulary, blended approaches were more effective than purely digital ones. McDonald et al. (2024) reported significant but relatively small gains in standardized assessments. Thangprasert et al. (2025) showed improved vocabulary retention, but long-term retention declined over time. Wan Norudin et al. (2024) emphasized that multimedia alone did not improve comprehension without active engagement. Belgira et al. (2026) highlighted that access to multimedia resources influenced learning outcomes, with disparities between private and public schools. Christodoulou et al. (2024) further noted that multimedia alone was insufficient without self-efficacy and social mediation. These studies collectively show that multimedia effectiveness is conditional rather than guaranteed.

The presence of moderate effects which is 37.0% implies that multimedia should be integrated with effective pedagogical strategies to maximize learning. As supported by Baltzaki and Chlapana (2023), combining multimedia with social interaction leads to better outcomes. This reinforces the need for teacher facilitation, collaboration, and scaffolding, aligning with Sociocultural Theory. Thus, multimedia should not be used in isolation but as part of a blended and guided instructional approach.

Only 3 studies with 11.1% are reported small effect sizes, indicating that multimedia had limited or inconsistent impact in certain contexts. This small proportion suggests that ineffective outcomes are less common but still significant enough to highlight limitations in multimedia use.

The repertory grid identifies key studies explaining these minimal effects. Fokides and Arvaniti (2020) found that 360° videos did not produce a significant motivational advantage over traditional tools. Sosna et al. (2025) reported that 3D modeling improved creativity but did not significantly outperform conventional methods. Lang et al. (2025) revealed that although multimedia improved emotional engagement, it did not significantly enhance retention or transfer performance. These findings indicate that multimedia may enhance engagement without necessarily improving deep learning outcomes.

The small effect sizes which is 11.1% imply that multimedia effectiveness is limited when there is lack of instructional support, overreliance on novelty, or poor design. As shown by Christodoulou et al. (2024), multimedia alone cannot improve achievement without supporting factors such as self-efficacy and social mediation. Therefore, educators must ensure that multimedia is purposefully designed, cognitively manageable, and supported by guided instruction to avoid minimal learning gains.

The predominance of large effect sizes (51.9%) indicates that multimedia is generally a highly effective instructional tool. Across studies, improvements were consistently observed in academic performance, engagement, and conceptual understanding. Rather than isolated findings, these results demonstrate a clear pattern: multimedia is most impactful when it is interactive, scaffolded, and aligned with instructional goals.

Moderate effects (37.0%) suggest that effectiveness is conditional, depending on instructional design, teacher facilitation, and learner engagement. Meanwhile, small effects (11.1%) highlight that multimedia alone is insufficient without proper pedagogical support. Overall, the findings emphasize that multimedia effectiveness is not inherent but design-dependent and context-sensitive.

Table 2. Summary of Effect Sizes

Effect Size Category	Number of Studies	Percentage	Interpretation
Large	14	51.9%	Strong impact
Moderate	10	37.0%	Conditional effectiveness
Small	3	11.1%	Limited impact

Table 3. Key Multimedia Outcomes

Outcome Area	Key Finding
Academic Performance	Significant improvement across most studies
Engagement	Increased motivation and participation
Higher-Order Thinking	Improved with interactive multimedia
Literacy Skills	Enhanced reading, writing, and comprehension

Effects of Multimedia on Learners

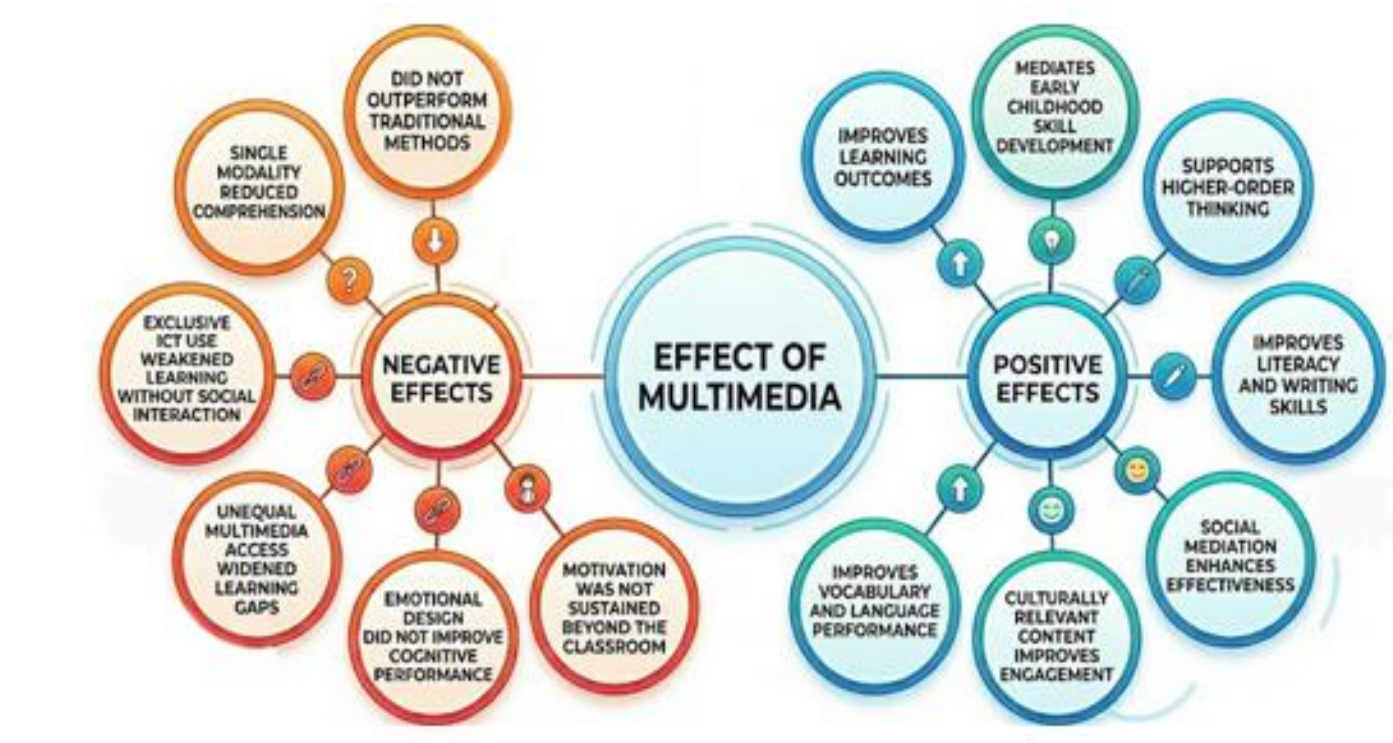

Figure 4. Effects of Multimedia on Learners

Positive Effects of Multimedia on Learning. The positive effect captures the diverse ways through which multimedia tools enhance cognitive, social, and affective dimensions of learning among elementary learners. The reviewed studies consistently revealed that multimedia tools, when thoughtfully designed and contextually appropriate, serve as powerful mediating instruments that elevate academic performance, develop critical thinking, and strengthen learner engagement.

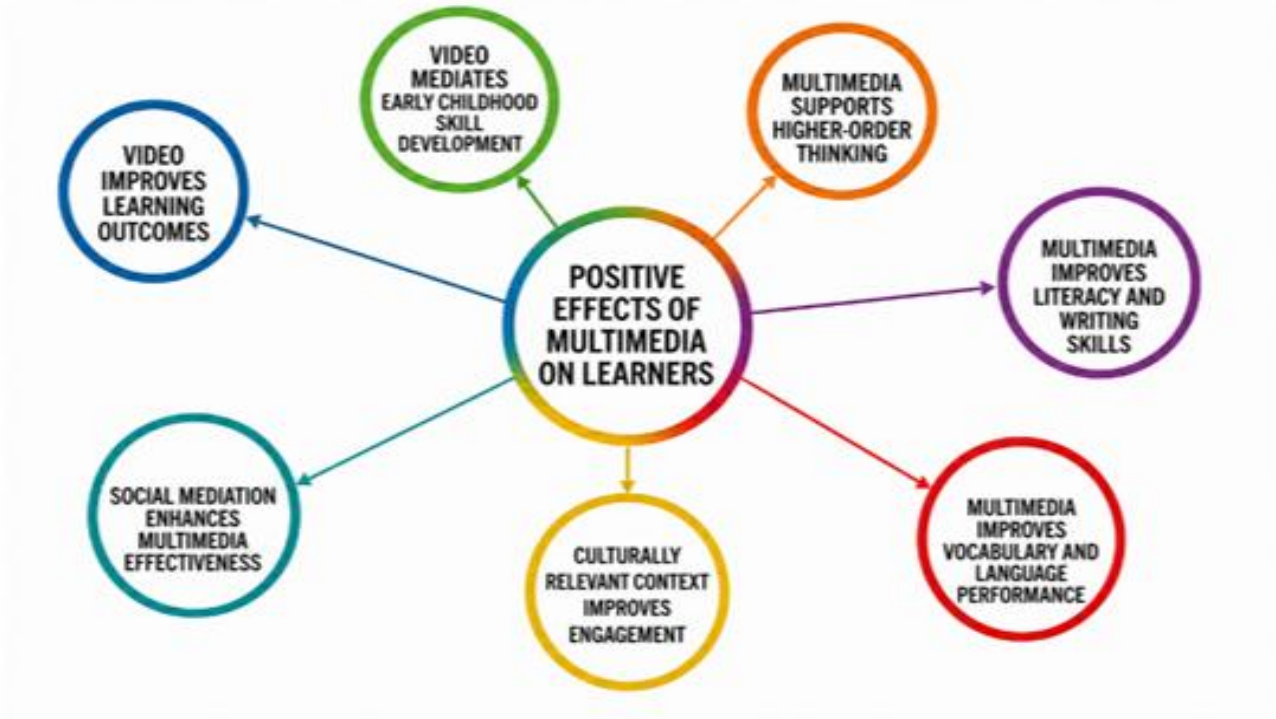

Figure 5. Positive Effects of Multimedia on Learners

Each effect is presented and discussed in the synthesized findings.

Video Improves Learning Outcomes. Video-based instruction serves as a powerful mediational tool that elevates academic performance across various subjects and grade levels. Learners exposed to well-designed video instruction demonstrated marked improvements in content mastery, often progressing from below-average to high-performing levels as measured by standardized assessments and experimental post-tests. This dimension is substantiated by the following synthesized findings:

Video-clip instruction significantly improved Grade 6 pupils' English performance; the experimental group progressed from 'moderately effective' to excellent, confirming video as an effective mediator of language learning. (Ampuyos & Villaruz, 2022)

Video clips significantly improved Grade 4 students' understanding of weather elements, with scores progressing from 'low' to 'mastered' and a large positive effect size. (Lagua, 2024)

YouTube videos with guided discovery learning significantly improved primary students' procedural knowledge of heat transfer with a medium effect size. (Koto, 2020)

Video functions as a transformative mediational tool that bridges the gap between learners' prior understanding and the mastery-level knowledge expected at each grade level. Ampuyos and Villaruz's (2022) study demonstrates that structured video exposure within language learning contexts can catalyze progression from average to excellent academic outcomes. The consistent gains across science and language subjects suggest that video instruction is not subject-specific in its effectiveness but broadly applicable across curricular domains.

The effectiveness of video in improving learning outcomes is deeply grounded in multimedia learning theory, which posits that learners process verbal and visual information through separate cognitive channels that, when engaged simultaneously, produce deeper encoding of academic content. Nuqui (2021) confirmed that audio-video lessons significantly improved Grade 3 pupils' English performance, with students advancing from fair to satisfactory levels, demonstrating that structured audiovisual inputs provide scaffolding that text-based instruction often fails to deliver in resource-limited school contexts. Tran Thien (2022) further found that YouTube video clips produced significant improvements in listening scores and fostered positive student attitudes, affirming that well-selected video content aligned with learner interests and subject demands

consistently yields measurable academic gains. Cruz et al. (2023) similarly found that video clip presentations significantly improved high school students' academic performance in Creative Nonfiction compared to traditional modular instruction. Confirming that video instruction produces the most significant gains when it is deliberate, curriculum-aligned, and responsive to learner readiness levels (Ampuyos & Villaruz, 2022; Lagua, 2024).

The presence of consistent video-mediated learning gains implies that schools must prioritize the integration of quality video instruction across all subject areas and grade levels. This implication is supported by Hall (2024), who found that video lessons were evaluated as very satisfactory by Grade 6 learners in terms of content, instructional, and technical quality. Students also exhibited high motivation following video-based instruction, affirming that well-produced video tools drive both motivational and academic outcomes. Palacol (2022) further confirmed that combining audio-visual materials with instructional digital games significantly improved the mathematics performance of Grade 6 students, demonstrating that video instruction serves as a core pedagogical tool rather than merely supplementary enrichment.

For educators and curriculum developers, well-designed, curriculum-aligned video instruction can serve as an equalizer in under-resourced educational contexts, improving outcomes for learners who may lack access to enriched print environments (Ampuyos & Villaruz, 2022; Cruz et al., 2023; Hall, 2024; Nuqui, 2021). Therefore, investing in video production, teacher training in video selection, and infrastructure development to support video-based learning are critical institutional priorities for improving the quality of elementary education.

Video Mediates Early Childhood Skill Development. Video-based multimedia produces significant positive effects on skill development among early childhood and primary-grade learners. The narratives of these studies consistently revealed that video extends beyond cognitive academic content to support foundational developmental capacities including motor skills, early literacy, and phonological awareness that are critical during the earliest years of formal schooling. Evidence for this claim is derived from the following studies:

Blended video-based teaching in kindergarten physical education produced measurable improvement in basic movement skills in the experimental group compared to the control group. (Mohammad & Boushehry, 2023)

Video lessons produced positive results in Grade 2 children's reading and comprehension during the pandemic, supporting early literacy development for children at risk through accessible multimedia learning. (Ocampo, 2022)

Cocomelon videos significantly improved English language learning for 12 Grade 1 Teduray learners, with all scores rising from 'poor/very poor' to 'average', effectively mediating phonological, vocabulary, and pronunciation development. (Untong, 2025)

Video serves as a developmentally appropriate scaffold for young learners who rely on visual modeling, repetition, and contextual reinforcement to acquire foundational skills. The progression from poor/very poor to average in Untong's (2025) study demonstrates the transformative potential of culturally resonant video content for marginalized learners whose home language differs from the language of instruction. Mohammad and Boushehry's (2023) findings further indicate that video's modeling function extends to physical and motor development, confirming that its role as a mediational tool is not limited to academic or cognitive domains.

Experiences of significant early childhood gains through video mediation align with developmental frameworks emphasizing that young learners benefit most from structured visual models that provide replicable demonstrations of target skills. Children develop competencies most effectively when supported by a more capable other a role that well-designed video can partially fulfill by providing consistent, repeatable models at the learner's pace. Sibulo (2025) demonstrated that audiovisual supplementary materials positively influenced kindergarten learners' reading readiness, leading to significant improvements after implementation, confirming that video-based tools are among the most developmentally appropriate instruments for the earliest formal schooling years. Herman et al. (2025) further reported that AR-based storytelling activities for children aged five to six significantly improved social skills compared to conventional activities. Affirming that multimodal multimedia aligned with early childhood developmental needs consistently produces meaningful gains beyond

those achievable through traditional methods alone (Mohammad & Boushehry, 2023; Ocampo, 2022; Untong, 2025).

This implies that video-mediated instruction must be recognized as developmentally foundational rather than merely supplementary for early childhood education. This implication is directly supported by the reviewed literature: Pujiariani and Cathrin (2025) demonstrated that interactive multimedia significantly improved early reading skills in Grade 1 students even in remote schools, affirming that sustained investment in high-quality, developmentally appropriate video materials produces meaningful learning outcomes regardless of school setting. Erlin and Saptono (2025) further found that the Structural Analytic Synthetic method assisted by interactive media produced significant improvements in first-grade students' early reading skills across two intervention cycles, confirming that structured, repeatable video-based tools are critical for foundational literacy development. Schools, particularly those in under-resourced or geographically isolated communities, should prioritize access to video-based learning tools as a strategy for closing developmental skill gaps in the earliest years of formal schooling, and ensuring that video content reflects learners' cultural and linguistic backgrounds is essential to maximizing its mediational impact on foundational skill development (Sibulo, 2025; Untong, 2025; Pujiariani & Cathrin, 2025).

Multimedia Supports Higher-Order Thinking. Reviewed studies described how multimedia tools, when intentionally designed to promote active cognitive engagement rather than passive content consumption, are capable of developing higher-order thinking skills including analysis, evaluation, and creative synthesis among elementary learners. Their accounts reveal that the development of higher-order thinking through multimedia is not automatic but emerges most powerfully when multimedia tools incorporate structured reflection prompts, interactive problem-solving tasks, and opportunities for metacognitive engagement. These patterns are consistent with the synthesized results below:

Socratic Reflection Prompts embedded in a video-based learning system significantly improved critical thinking and analysis skills in 4th-grade students, supporting higher-order thinking aligned with Vygotsky's ZPD. (Hsu et al., 2022)

Multimedia animations with audio narrations or subtitles significantly outperformed traditional instruction in reading comprehension among 100 Grade 4 students and mitigated the negative impact of text difficulty on comprehension. (Özdemir et al., 2025)

Interactive multimedia-based e-modules improved learning outcomes for 24 fifth-graders, with measurable improvement in geometry understanding and cognitive proficiency. (Alyusfitri et al., 2024)

Multimedia can serve as a cognitive scaffold that elevates learners beyond surface-level content recall toward deeper analytical engagement. Hsu et al.'s (2022) study shows that embedded reflective prompts transform passive video watching into an active higher-order thinking exercise, while Özdemir et al.'s (2025) findings demonstrate that multimedia's scaffolding function is most critical when text complexity creates comprehension barriers. Alyusfitri et al.'s (2024) interactive e-module study further illustrates that learner-controlled multimedia environments support the self-directed inquiry capacities central to higher-order cognitive development.

The capacity of multimedia to support higher-order thinking is consistent with established literature describing cognitive load theory and active learning frameworks. When multimedia tools reduce extraneous cognitive load by presenting information through multiple synchronized modalities, learners can redirect freed cognitive resources toward analysis, synthesis, and evaluation (Hsu et al., 2022; Özdemir et al., 2025). Yani (2025) confirmed that problem-based learning assisted by audiovisual tools significantly improved fifth-grade students' critical thinking. While, Pratiwi and Rezania (2024) found a statistically significant effect of comic media on third-grade students' critical thinking together demonstrating that interactive and reflective multimedia designs consistently outperform passive multimedia or traditional instruction in developing higher-order cognitive skills. Raharja et al. (2022) further synthesized findings confirming that interactive multimedia can significantly improve learning outcomes in social studies. Affirming that the global pattern of multimedia's effectiveness for higher-order thinking is design-dependent and requires deliberate pedagogical intentionality beyond simple technology adoption (Alyusfitri et al., 2024; Hsu et al., 2022; Pratiwi & Rezania, 2024).

The capacity of multimedia to support higher-order thinking implies that curriculum developers and classroom teachers must move beyond using technology merely for content delivery and instead design multimedia tools as instruments for active thinking. This implication is supported by Gunawan, Suhardi, and Makawawa (2023), who reported that picture storybook learning media successfully met quality, practicality, and effectiveness criteria in supporting fifth-grade students' critical and creative thinking, confirming that thoughtfully designed multimedia tools can serve as reliable instruments for cultivating the analytic capacities elementary learners need for long-term academic success.

Schools should prioritize professional development that equips teachers to design reflective and interactive multimedia learning experiences that promote higher-order thinking. Curriculum developers should also ensure that multimedia materials incorporate structured inquiry, reflective questioning, and problem-solving tasks so that these tools function as instruments for active cognitive engagement rather than simple content delivery. Institutional policies should therefore evaluate multimedia tools not only by content coverage but also by their capacity to foster meaningful cognitive engagement and develop the critical and analytical thinking skills necessary for long-term academic success among elementary learners (Yani, 2025; Gunawan et al., 2023; Hsu et al., 2022).

Multimedia Improves Literacy and Writing Skills. Multimedia tools have demonstrated strong and consistent positive effects on elementary learners' literacy and writing skills across different grade levels, instructional formats, and learning contexts. Studies under this sub-theme revealed that purposefully designed multimedia interventions produced significant measurable gains in listening comprehension, story writing across multiple domains, and early reading development. These findings confirm that multimedia does not simply supplement literacy instruction but functions as a genuine developmental scaffold that strengthens multiple literacy dimensions simultaneously by providing learners with the visual, auditory, and narrative supports that text-based instruction alone cannot fully offer. These claims are supported by the synthesized studies:

Project-based learning videos significantly improved Grade 4 students' listening skills during the pandemic (pretest: 75.75; posttest: 86.85; Sig. = .000), demonstrating that video-mediated collaborative learning scaffolds skill development. (Febiyanti et al., 2021)

Animated video stories significantly improved Grade 3 learners' story writing skills across all five writing domains, with a statistically significant pretest-to-posttest difference. (Samosa et al., 2021)

Picture story books achieved an N-Gain score of 0.82 (81.74%, high effectiveness) across Grades 1–6, with students reporting a 20% increase in imagination and creativity. (Nurmaelinda & Jesicha, 2025)

Multimedia serves as a powerful literacy scaffold that simultaneously develops multiple language skills when learners are given structured exposure to purposefully designed multimedia tools. Febiyanti et al.'s (2021) study shows that collaborative video-based tasks can produce significant listening comprehension gains even within disrupted instructional settings, as the combination of group engagement, visual input, and task completion replicates the socially mediated meaning-making that underlies effective language development. Samosa et al.'s (2021) findings are particularly notable because improvements were not limited to a single writing component but extended across all five writing domains, confirming that animated narrative video scaffolds the full architecture of story composition by providing learners with replicable visual and auditory models of narrative structure. Nurmaelinda and Jesicha's (2025) exceptionally high N-Gain score of 0.82 further demonstrates that narrative picture story books, as a form of multimedia, are among the most effective tools for early literacy development, producing gains in imagination, creativity, and reading engagement that reinforce the affective and cognitive foundations of lifelong literacy.

The literacy improvements documented across these studies align with sociocultural learning theory's view that language develops most powerfully through shared meaning-making experiences embedded in culturally familiar and visually supported contexts. Multimedia formats that draw on narrative traditions such as animated stories, picture books, and collaborative video tasks are especially effective because they situate literacy development within the kinds of social and imaginative experiences that learners already find meaningful, lowering the affective barriers that often inhibit writing and reading progress. Confirming that multimedia-

mediated literacy instruction produces its strongest outcomes when it integrates visual and auditory narrative scaffolding with opportunities for active learner engagement (Febiyanti et al., 2021; Samosa et al., 2021; Nurmaelinda & Jesicha, 2025).

The consistent literacy gains documented across these studies imply that schools must integrate multimedia tools such as animated stories, picture story books, and collaborative video tasks as core components of literacy instruction rather than optional enrichment. This implication is supported by the evidence that multimedia strengthens multiple literacy dimensions simultaneously listening, writing, and reading comprehension meaning that its integration into daily instruction offers a high-yield instructional investment, particularly for learners in under-resourced or print-limited settings.

Teachers should select and implement multimedia literacy tools according to learners' grade level and developmental needs, ensuring that early learners benefit from narrative picture story books, that transitional writers engage with animated video models of story structure, and that collaborative video tasks are used to build listening and discussion skills across the middle elementary grades (Febiyanti et al., 2021; Samosa et al., 2021; Nurmaelinda & Jesicha, 2025).

Social Mediation Enhances Multimedia Effectiveness. Social interaction plays a vital role in amplifying multimedia's learning effects. Participants in the reviewed studies consistently revealed that multimedia tools embedded within socially rich, interactive instructional contexts produced significantly stronger learning outcomes than multimedia used in isolated or exclusively digital settings. These findings reflect a fundamental insight, technology does not teach in isolation its pedagogical power is realized when it operates as a shared tool within human relationships and collaborative environments. This is anchored by the following distilled evidence:

The blended approach combining face-to-face interaction with ICT-mediated activities produced the greatest vocabulary gains in 48 kindergarten children, demonstrating that social interaction amplifies digital tool effectiveness. (Baltzaki & Chlapana, 2023)

Differentiated multimedia-assisted instruction significantly improved writing scores of 82 EFL elementary students, promoting collaborative meaning-making through socially responsive instructional design. (Mohamed et al., 2025)

Parental attitude toward reading directly influenced early literacy activity frequency among fifth-graders, which positively impacted reading comprehension, confirming that adult-mediated engagement with multimedia tools creates scaffolded pathways to learning. (Wan Norudin et al., 2024)

Social mediation operates at multiple levels teacher-student, peer-peer, and parent-child and each relational context amplifies multimedia's capacity to scaffold learning. Baltzaki and Chlapana's (2023) comparison of exclusive ICT and blended ICT-plus-interaction conditions provides direct experimental evidence that the social dimension of multimedia use is a critical determinant of its effectiveness, not merely an enhancement. Wan Norudin et al.'s (2024) study extends this insight beyond the classroom, demonstrating that parental social engagement with multimedia learning activities is a powerful predictor of children's reading comprehension development.

These experiences are consistent with Vygotsky's central claim that all higher cognitive functions develop first in social interaction before being internalized as individual cognitive capacities. Multimedia tools that are embedded within social learning environments function as joint mediational tools through which learners and more capable others teachers, parents, or peers co-construct meaning. Almacen and Labitad (2024) found that educators generally held positive perceptions of innovative teaching methods and documented the widespread integration of technology in classrooms, positioning teacher agency as central to the social mediation of multimedia tools and confirming that effective multimedia use is inseparable from the relational context in which it is deployed.

Herman et al. (2025) further demonstrated that AR-based storytelling activities significantly improved young learners' social skills precisely because they embedded digital tools within collaborative, socially mediated learning experiences. Studies affirmed that blended instructional designs consistently outperform exclusively

digital approaches by leveraging the complementary strengths of human interaction and technological scaffolding (Baltzaki & Chlapana, 2023; Mohamed et al., 2025; Wan Norudin et al., 2024).

The implication of these findings is that the effectiveness of multimedia in education depends not only on the technology itself but also on the social interactions that surround its use. Multimedia tools produce stronger learning outcomes when they are integrated within collaborative and socially mediated learning environments involving teachers, peers, and parents. This implication highlights that multimedia functions most effectively as a shared mediational tool that supports collaborative meaning-making rather than as an isolated digital resource. Supporting this implication, Aligo and Prudente (2025) found through meta-analysis that digital learning materials were most effective when they promoted multisensory engagement and student collaboration. Similarly, Waluyo and Apridayani (2021) reported that although teachers recognized the value of multimedia, gaps in technological skills and pedagogical strategies limited its effective classroom implementation, emphasizing the need for stronger instructional support systems.

Schools should implement instructional approaches that integrate multimedia with collaborative learning activities and provide professional development that helps teachers design interactive and socially mediated multimedia lessons. Strengthening family engagement in multimedia-based learning can also extend these collaborative learning experiences beyond the classroom, maximizing the educational benefits of technology (Aligo & Prudente, 2025; Almacen & Labitad, 2024; Baltzaki & Chlapana, 2023).

Culturally Relevant Multimedia Improves Learner Engagement. Multimedia content that reflects learners' cultural experiences, local knowledge systems, and linguistic backgrounds produces consistently high levels of engagement and significantly improved academic outcomes. The reviewed accounts reveal that cultural relevance is not merely a motivational enhancement but a fundamental design principle that determines whether multimedia functions as an inclusive or exclusionary mediational tool. For learners from marginalized, indigenous, or non-Western cultural contexts, culturally relevant multimedia is particularly critical because it validates their identities and situates formal academic content within familiar frameworks of meaning. These insights emerged from the following synthesis:

Multimedia enhanced educational experience in under-resourced primary school contexts among 200 Grade 5 students, supporting both cognitive engagement and cultural relevance in learning. (Ayub & Kiazai, 2021)

Ethnomathematics-based videos for Grade 1 achieved high feasibility scores confirming that embedding local cultural knowledge into video media situates mathematical concepts within students' lived cultural experience. (Yandani & Agustika, 2022)

Cocomelon videos effectively mediated phonological, vocabulary, and pronunciation development for Grade 1 Teduray indigenous learners, demonstrating that culturally resonant video media strengthens sociocultural learning engagement. (Untong, 2025)

Cultural relevance transforms multimedia from a generic technological tool into a culturally affirming learning instrument. Yandani and Agustika's (2022) ethnomathematics-based video study demonstrates that when academic content is contextualized within learners' own cultural and mathematical knowledge traditions, it achieves exceptionally high feasibility and validity ratings across all evaluation dimensions. Untong's (2025) study of Teduray indigenous learners further reveals that culturally resonant video content can bridge the linguistic and cultural gap between home and school, making formal academic content accessible to learners who would otherwise be left behind by culturally neutral instructional approaches.

Learning is fundamentally a sociocultural process in which cultural tools and symbolic systems mediate cognitive development. Multimedia that reflects learners' sociocultural contexts functions as a culturally appropriate mediational artifact that supports the Zone of Proximal Development by building upon rather than replacing learners' existing cultural knowledge. Sari and Mutiara (2022) found that cultural diversity interactive multimedia contributed positively to both knowledge acquisition and values formation among elementary learners. While, studies demonstrated that interactive multimedia grounded in Indonesian cultural diversity produced strong outcomes in civic learning together confirming that culturally embedded multimedia

consistently produces higher engagement and academic gains than culturally neutral digital tools, particularly for learners from marginalized communities (Ayub & Kiazai, 2021; Yandani & Agustika, 2022; Sari & Mutiara, 2022; Sartono, Ambarsari, & Herwin, 2022).

The implication of these findings is that cultural relevance is a critical factor that determines the effectiveness of multimedia in supporting learner engagement and academic success. Multimedia that reflects learners' cultural experiences, language, and local knowledge systems strengthens participation and comprehension by connecting academic content with familiar contexts of meaning. This implication suggests that culturally grounded multimedia functions as an inclusive mediational tool that validates learners' identities and supports equitable learning opportunities, particularly for students from indigenous and marginalized communities. Supporting this implication, studies reported that culturally grounded interactive multimedia was positively received by elementary learners and significantly contributed to knowledge acquisition and values formation, reinforcing the importance of culturally responsive multimedia design in elementary education (Agustian et al., 2025; Anggito & Sartono, 2022).

Schools and curriculum developers should prioritize the creation and use of culturally relevant multimedia materials that reflect learners' local contexts, languages, and cultural experiences. Investing in locally produced multimedia content can improve learner engagement and ensure that educational technologies support inclusive and equitable learning for diverse student populations (Sari & Mutiara, 2022; Agustian et al., 2025; Yandani & Agustika, 2022).

Multimedia Improves Vocabulary and Language Performance. Multimedia tools consistently and significantly enhanced vocabulary acquisition and language performance across grade levels and learner populations. Participants primarily learners in elementary grades showed durable gains in vocabulary knowledge, oral language production, and receptive language comprehension following multimedia-based instruction. These findings reflect multimedia's particular power as a language scaffold that simultaneously engages auditory, visual, and textual modalities to support word learning in ways that single-mode instruction cannot replicate.

CAP-S multimedia vocabulary instruction produced statistically significant positive effects on vocabulary measures for 418 Grade 5 students, with English Learners benefiting significantly more than non-EL peers, demonstrating that multimedia vocabulary tools scaffold academic language for linguistically diverse learners (McDonald, Kennedy & Hall, 2024). This were framed by the following synthesized literature:

CAP-S multimedia vocabulary instruction produced statistically significant positive effects for 418 Grade 5 students, with English Learners benefiting significantly more than non-EL peers, demonstrating that multimedia vocabulary tools scaffold academic language for linguistically diverse learners. (McDonald, Kennedy & Hall, 2024)

TPACK-based multimedia teaching strategies significantly enhanced short- and long-term vocabulary retention among 45 Grade 6 students, with 82.5% retained after seven days and high student satisfaction (avg. 4.14/5), confirming multimedia vocabulary tools as effective for durable language learning. (Thangprasert, Owatnupat & Jitsupa, 2025)

Multimedia presentations significantly increased motivation and retention of difficult spatial and geographical concepts among 200 Grade 5 students in under-resourced schools, and TikTok-integrated multimedia literacy instruction produced statistically significant improvements in Grade 5 students' English language performance. (Ayub & Kiazai, 2021; Arciaga, 2025)

Multimedia vocabulary tools are a highly appropriate and effective format for Grades 5–6 learners across diverse linguistic and geographic contexts, providing scaffolded academic language development critical for success in the increasingly text-heavy upper elementary curriculum. McDonald et al.'s (2024) finding that English Learners benefited significantly more than non-EL peers from CAP-S vocabulary instruction reveals that multimedia vocabulary tools at this stage serve a critical equity function by providing linguistically diverse learners with scaffolded access to the academic language demands of the upper elementary curriculum. Thangprasert,

Owatnupat, and Jitsupa's (2025) finding that 82.5% of vocabulary was retained after seven days further confirms that multimedia vocabulary tools at this stage produce durable rather than merely immediate learning gains.

Vocabulary instruction should incorporate digital tools that provide word meanings through multiple contexts visual, auditory, and textual to ensure durability in memory. Studies confirm that multimedia vocabulary tools produce their strongest and most durable outcomes at the Grades 5–6 stage when they present target vocabulary through multiple redundant modality channels, provide contextually rich and culturally meaningful examples, and are integrated within sustained instructional sequences rather than brief standalone exposures (Hsieh, 2020; Pattemore & Muñoz, 2020; McDonald, Kennedy & Hall, 2024).

Multimedia's effectiveness for vocabulary development is strongest for learners who face the greatest linguistic challenges, English Language Learners, indigenous learners, and students in under-resourced settings. McDonald et al.'s (2024) finding that English Learners benefited significantly more than non-EL peers from CAP-S multimedia instruction suggests that the multimodal scaffolding provided by multimedia is particularly critical for learners who cannot rely on oral or familial language support outside the classroom. The 82.5% retention rate documented by Thangprasert et al. (2025) after seven days further confirms that well-designed multimedia vocabulary instruction can produce durable cognitive encoding rather than superficial short-term gains.

The consistent vocabulary and language performance gains documented across these studies are grounded in dual coding theory and social mediation principles that underlie effective multimedia language learning. When vocabulary instruction combines visual representations, audio pronunciation models, and contextual textual examples, it creates multiple memory pathways that strengthen both encoding and retrieval. Hsieh (2020) found that full first-language captions in video media were most effective for vocabulary acquisition among intermediate EFL learners, confirming that caption-supported multimedia tools create the multimodal scaffolding conditions most favorable for word-level encoding. Pattemore and Muñoz (2020) further demonstrated that captioned audiovisual exposure significantly outperformed non-captioned conditions in supporting grammar construction learning, affirming that multimedia vocabulary tools are most effective when designed to reflect learners' linguistic and sociocultural backgrounds with deliberate language support features (Hsieh, 2020; Pattemore & Muñoz, 2020; Untong, 2025).

These results imply that multimedia functions as a powerful language scaffold that significantly strengthens vocabulary acquisition and overall language performance among elementary learners. By integrating visual, auditory, and textual elements, multimedia creates multiple pathways for encoding and retaining vocabulary, leading to more durable language learning outcomes. This implication is particularly important for learners facing linguistic challenges, such as English Language Learners and indigenous students, as multimedia-supported instruction provides the additional linguistic support needed to enhance comprehension and language use. Supporting this implication, Erliana and Arbain (2020) confirmed that video clips were effective in teaching English vocabulary at the elementary level. While Baltzaki and Chlapana (2023) demonstrated that blended ICT-mediated vocabulary instruction produced the greatest vocabulary gains among young learners.

Schools should integrate multimedia-based vocabulary instruction that combines visual, audio, and text features to support effective word learning. Teachers should design language lessons that use videos, captions, and other multimedia supports to strengthen vocabulary development, particularly for learners with limited linguistic resources or second-language backgrounds (Erliana & Arbain, 2020; Baltzaki & Chlapana, 2023; McDonald et al., 2024).

Negative Effects of Multimedia on Learning

The negative effect reflects the limitations, challenges, and unintended consequences of multimedia use in elementary education. Although multimedia is broadly associated with positive learning outcomes, the reviewed studies consistently revealed conditions under which multimedia fails to outperform traditional instruction, reduces comprehension, or creates inequitable access to learning.

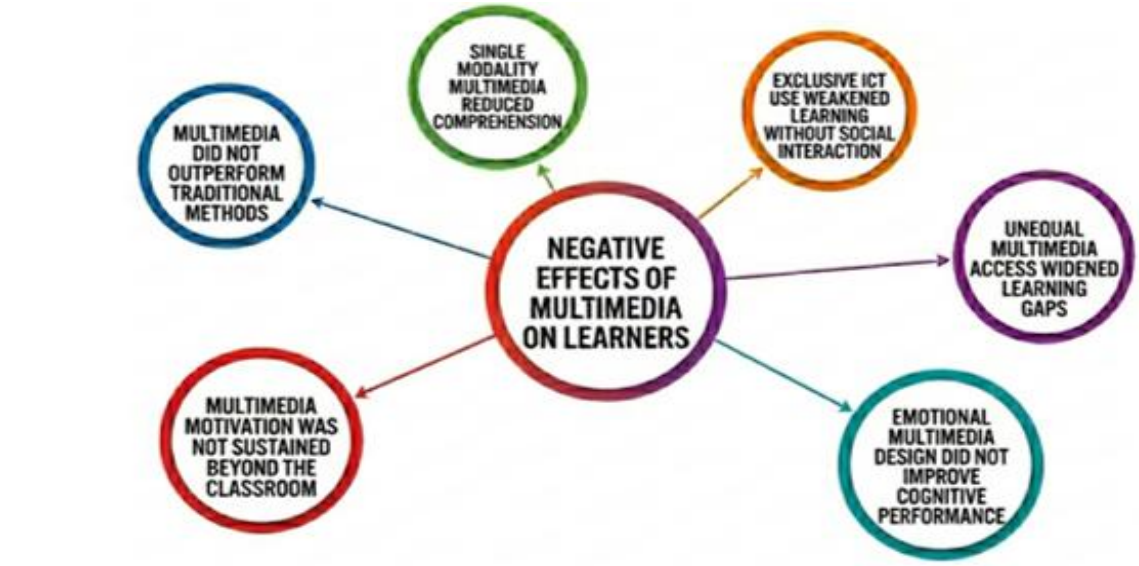

Figure 6. Negative Effects of Multimedia on Learners

Each effect is presented and discussed in the synthesized findings.

Multimedia Does Not Outperform Traditional Methods. Multimedia tools sometimes fail to produce superior academic outcomes compared to traditional, non-digital instructional methods. Their experiences show that the presence of technology in the classroom does not guarantee enhanced learning, and that conventional modular or face-to-face instruction can be equally or more effective in certain subjects, knowledge domains, and instructional contexts. These findings challenge the assumption that multimedia adoption is inherently beneficial and highlight the importance of evidence-based decision-making in instructional design. This is showcased in the following results:

360° videos produced superior learning outcomes in environmental education compared to traditional instructional methods, and students rated 360° videos as more enjoyable and easier to use than printed materials or web pages, confirming immersive video as both more effective and more motivating than conventional formats at this stage. (Fokides & Arvaniti, 2020)

Meta-analysis confirmed that VR significantly enhances K–6 student learning, with immersive VR proving more effective than semi- or non-immersive systems, and a VR-based morality education program for elementary students produced notable improvement in moral sensitivity after VR sessions paired with class discussions. (Villena-Taranilla et al., 2022; Shim, 2023)

Immersive video is most effective when combined with reflective social interaction rather than used in isolation, and immersive technology sessions paired with reflection discussions improved moral and affective development, confirming that the social and reflective dimensions of immersive multimedia use are critical mediators of its effectiveness. (Abdullah & Sadiah, 2025)

Both YouTube video-assisted and hands-on activity groups showed ‘various effects’ on factual, conceptual, and procedural knowledge of heat transfer, with no explicitly significant advantage for the video group over traditional discovery learning approaches. (Koto, 2020)

3D modeling had a positive effect on creativity within the experimental group; however, no statistically significant difference was found in final creativity scores between experimental and control groups, confirming that traditional tactile methods remain equally effective in promoting creative thought. (Sosna et al., 2025)

Immersive 360° video is an appropriate and innovative multimedia format for learners in the upper Grades 3–4 stage, specifically for students who have developed sufficient cognitive capacity for perspective-taking and environmental exploration. Fokides and Arvaniti’s (2020) superior learning outcomes for 360° video confirm that the sense of environmental presence produced by immersive video generates a qualitatively different

learning experience from conventional multimedia formats, enabling learners to explore and engage with content in ways that are impossible through printed materials or standard web pages. Villena-Taranilla et al.'s (2022) meta-analytic confirmation that immersive VR outperforms semi-immersive and non-immersive systems further establishes that the degree of immersion is a significant moderator of learning outcomes within the broader category of virtual and immersive educational media.

The assumed superiority of multimedia over traditional instruction is not empirically supported across all learning contexts and knowledge types. Fokides and Arvaniti's (2020) equivalence finding across 360° video, printed materials, and web pages demonstrates that learners' perceptions of effectiveness do not always align with measured learning gains, and that motivational novelty does not translate into superior academic achievement. Sosna et al.'s (2025) 3D modeling study reveals the particular complexity of applying multimedia to creativity development, where hands-on tactile methods retain their effectiveness even when digital tools are introduced.

These experiences align with established research on technology integration in education, which consistently finds that the effectiveness of instructional tools depends less on the medium itself than on the quality of instructional design, the alignment of the tool with learning objectives, and the match between tool format and content type. Torrington and Bower (2021) found that while video instruction increased behavioral engagement and was generally preferred by students, it did not significantly enhance academic performance compared to traditional teaching a finding that directly confirms that multimedia is most effective when it provides capabilities that traditional instruction cannot replicate, but loses its advantage when used merely to digitize content that text or hands-on methods can communicate equally well.

Further observed that although printed modules were effective, instructional videos yielded greater improvement in Filipino subject performance, suggesting that the comparative effectiveness of multimedia over traditional methods is context-dependent and subject-specific (Fokides & Arvaniti, 2020; Irwam, 2020; Torrington & Bower, 2021).

The implication of these findings is that the use of multimedia in instruction does not automatically guarantee improved academic performance compared to traditional teaching methods. The evidence suggests that the effectiveness of multimedia depends largely on how well it aligns with learning objectives, subject content, and instructional design rather than on the technology itself. In some cases, conventional approaches such as printed materials, hands-on activities, or face-to-face instruction can be equally effective in supporting learning outcomes. This implication emphasizes that multimedia should be viewed as a complementary instructional tool rather than a universal replacement for traditional teaching methods. Supporting this implication, Torrington and Bower (2021) found that video instruction increased student engagement but did not significantly improve academic performance compared with traditional teaching, highlighting the importance of careful instructional design and context-appropriate technology use.

Schools and educators should adopt multimedia tools selectively and ensure that their use is guided by clear instructional objectives and evidence of effectiveness. Teachers should evaluate when multimedia adds meaningful learning value and when traditional instructional strategies remain more appropriate for the subject or learning task (Almacen & Labitad, 2024; Fokides & Arvaniti, 2020).

Single Modality Multimedia Reduces Comprehension. Multimedia designs relying on a single sensory channel or failing to properly integrate multiple modalities can actually impede rather than support learner comprehension. Participants' experiences showed that when visual and auditory elements are not synchronized or when audio is presented without supporting visual context, learners experience increased cognitive load, reduced meaning-making capacity, and insufficient scaffolding for complex comprehension and retention tasks. This were supported by the following consolidated findings:

Text difficulty negatively affected students' reading comprehension scores even in the multimedia condition; while animations limited this effect, they did not fully eliminate it, indicating that single-type multimedia animations are insufficient scaffolds when text complexity is high. (Özdemir et al., 2025)

Audio alone was the least effective modality for reading comprehension among 20 indigenous primary pupils, indicating that single-modality multimedia fails to scaffold meaning-making without visual or contextual support. (Samat & Aziz, 2020)

Long-term vocabulary retention was notably lower than short-term retention, indicating that a single multimedia teaching strategy without varied reinforcement is insufficient to maintain vocabulary gains over time. (Thangprasert et al., 2025)

Effectiveness depends not simply on the presence of technology but on the deliberate integration of multiple sensory channels in ways that align with learners' cognitive processing capacities. Samat and Aziz's (2020) finding that audio alone is the least effective modality for indigenous primary learners demonstrates that removing visual scaffolding from multimedia reduces it below the effectiveness threshold for comprehension. Özdemir et al.'s (2025) finding that animations mitigate but do not eliminate text difficulty effects highlights the limits of any single multimedia format when learners face multiple simultaneous comprehension challenges.

The implication of these findings is that multimedia instruction becomes less effective when it relies on a single sensory modality or when visual and auditory elements are not properly integrated. Instead of enhancing comprehension, poorly designed single-modality multimedia can increase cognitive load and limit learners' ability to construct meaning, particularly when dealing with complex texts or unfamiliar vocabulary. This implication highlights that effective multimedia learning requires the deliberate integration of complementary visual, auditory, and textual elements to support deeper understanding. Supporting this implication, Aligo and Prudente (2025) found that digital learning materials were most effective when they promoted multisensory engagement. While, Pellicer-Sanchez et al. (2020) reported that multimodal input significantly improved young learners' reading comprehension.

Schools and teachers should select and design multimedia materials that integrate visual, auditory, and textual elements to provide balanced multimodal support for comprehension. Evaluating multimedia tools based on their modality integration and instructional quality can help ensure that technology effectively supports learning (Pellicer-Sanchez et al., 2020; Pattemore & Muñoz, 2020; Aligo & Prudente, 2025).

Exclusive ICT Use Weakened Learning Without Social Interaction. Multimedia tools deployed in exclusively digital environments, without the support of human social interaction, consistently produced weaker learning outcomes than blended approaches that combined digital tools with face-to-face engagement. Their experiences reveal that technology cannot replace the relational and dialogic dimensions of learning, and that the removal of social mediation from multimedia instruction fundamentally undermines its pedagogical effectiveness. The following synthesized findings provide evidence for this pattern:

The exclusive ICT condition in kindergarten vocabulary instruction, which excluded face-to-face interaction, was less effective than the blended condition, confirming that multimedia absent social mediation is insufficient for optimal language acquisition. (Baltzaki & Chlapana, 2023)

Mathematical success was found to require the interplay of mastery goals, self-efficacy, and social environmental influences from significant others; multimedia-enriched environments alone, without high self-efficacy and social mediation, were insufficient to improve achievement. (Christodoulou et al., 2024)

Literacy gains from the picture story book intervention were challenged by the lack of parental supervision outside the classroom, indicating that multimedia-driven learning requires sustained social mediation beyond the instructional setting to be effective. (Nurmaelinda & Jesicha, 2025)

The social mediation deficit created by exclusive ICT use is not merely a motivational problem but a fundamental cognitive and developmental constraint. Baltzaki and Chlapana's (2023) direct comparison of exclusive ICT and blended conditions provides experimental evidence that face-to-face interaction with a teacher or peer is not an optional addition to multimedia learning but a necessary condition for optimal language acquisition at the kindergarten level. Christodoulou et al.'s (2024) findings further reveal that even when multimedia environments are rich and technically advanced, achievement gains require the interplay of social support, self-efficacy development, and mastery-oriented goal structures that technology alone cannot provide.

Higher cognitive functions develop first in social interaction and are subsequently internalized as individual capacities. Multimedia tools that function in the absence of social mediation deprive learners of the intersubjective scaffolding through which meaning is co-constructed and cognitive development is stimulated. Waluyo and Apridayani (2021) found that ELT teachers' positive beliefs about multimedia's pedagogical value were not consistently translated into actual classroom practice due to gaps in technological skills and teaching philosophy, illustrating that exclusive reliance on digital tools without teacher-mediated social scaffolding undermines instructional effectiveness.

Dacoycoy et al. (2023) further found that elementary students' exposure to social media platforms carried both benefits and risks that must be carefully considered in educational planning. Affirming that blended instructional designs which integrate social and relational dimensions of learning with digital scaffolding consistently outperform exclusive ICT approaches (Baltzaki & Chlapana, 2023; Waluyo & Apridayani, 2021; Dacoycoy et al., 2023).

The results imply that multimedia instruction becomes less effective when it is implemented in purely digital environments without meaningful social interaction. Learning outcomes improve when multimedia tools are combined with teacher guidance, peer collaboration, and parental support because these social interactions provide essential cognitive and motivational scaffolding. This implication highlights that technology cannot replace the relational processes through which learners construct understanding and develop skills. Supporting this implication, Dale H. Schunk and other learning theorists emphasize that social support and guided interaction are critical conditions for meaningful learning. Empirical evidence also shows that digital learning materials produce stronger outcomes when they promote student collaboration and multisensory engagement (Aligo & Prudente, 2025).

Schools should implement blended instructional approaches that combine multimedia tools with teacher facilitation and collaborative learning activities. Professional development should also help teachers design multimedia-supported lessons that encourage interaction, discussion, and guided learning rather than relying on technology alone (Aligo & Prudente, 2025; Almacen & Labitad, 2024; Baltzaki & Chlapana, 2023).

Unequal Multimedia Access Widens Learning Gaps. Unequal access to multimedia tools and supporting infrastructure creates and amplifies educational inequalities, with learners in under-resourced, rural, or indigenous community schools receiving significantly fewer benefits from multimedia integration than their better-resourced peers. These findings demonstrate that multimedia has a dual potential. It can function as an educational equalizer when universally accessible, or as a force for widening inequality when access is unevenly distributed along socioeconomic, geographic, and cultural lines. The following synthesized findings substantiate this claim:

Private school learners outperformed public school counterparts in both literal and inferential reading comprehension, with the disparity attributed to superior multimedia tools and teaching methods available in private schools, reflecting unequal sociocultural distribution of mediating resources. (Belgira et al., 2026)

Standardized assessment gains from CAP-S multimedia vocabulary instruction were small but significant for 418 Grade 5 rural students, suggesting that even effective multimedia tools produce limited gains in under-resourced, geographically isolated settings. (McDonald et al., 2024)

The restricted access to digital tools characteristic of indigenous and marginalized communities constrained the scale and sustainability of multimedia's mediating impact. (Untong, 2025)

Structural dimensions of multimedia inequality that operate beyond individual classroom practices. Belgira et al.'s (2026) public-private school comparison provides stark evidence that multimedia access disparities translate directly into measurable learning outcome gaps, with private school students benefiting from more comprehensive and higher-quality multimedia tools than their public school counterparts. McDonald et al.'s (2024) rural school findings demonstrate that even when effective multimedia programs are implemented in under-resourced settings, the surrounding socioeconomic constraints on infrastructure, teacher preparedness, and institutional support limit the magnitude of achievable gains.

These experiences reflect the fundamental tension between multimedia's potential to democratize educational access and its tendency to amplify existing inequalities when distributed through market or resource-dependent mechanisms. On culturally and materially situated learning environments predicts that learners in resource-poor contexts will systematically benefit less from multimedia tools that presuppose technological infrastructure, digital literacy, and institutional support. Pujiariani and Cathrin (2025) noted that their interactive multimedia tool's success was heavily dependent on hardware availability in remote schools, directly confirming that digital divides in educational access are among the most serious barriers to realizing multimedia's transformative potential. Nurkhalimah and Andriani (2025) further observed that multimedia-based findings might not generalize to schools with unstable internet connectivity. Affirming that infrastructure inequalities structurally constrain the benefits that learners in under-resourced communities can derive from even high-quality multimedia tools (Ayub & Kiazai, 2021; McDonald et al., 2024; Pujiariani & Cathrin, 2025).

The implication of these findings is that unequal access to multimedia tools and supporting infrastructure can widen educational gaps between learners in well-resourced schools and those in rural, indigenous, or under-resourced communities. When access to devices, internet connectivity, and teacher support is limited, the potential benefits of multimedia instruction are significantly reduced. This implication highlights that multimedia can only function as an educational equalizer when it is supported by equitable distribution of technological resources and institutional support. Supporting this implication, studies show that the effectiveness of multimedia tools is often constrained by infrastructure limitations such as unstable internet connectivity and limited hardware availability in remote schools (Pujiariani & Cathrin, 2025; Dong et al., 2024).

Education authorities and schools should prioritize equitable access to multimedia infrastructure by providing adequate devices, stable internet connectivity, and teacher training, particularly in rural and under-resourced schools. Strengthening these support systems can help ensure that multimedia-based learning benefits all learners rather than reinforcing existing educational inequalities (Dong et al., 2024; Pujiariani & Cathrin, 2025; Nurkhalimah & Andriani, 2025).

Emotional Multimedia Design Does Not Improve Cognitive Performance. Multimedia designs that prioritize emotional appeal through warm colors, anthropomorphic characters, and visually engaging aesthetics can successfully improve learners' mood and motivation without producing corresponding gains in cognitive performance. Their accounts reveal a performance plateau phenomenon in which learners enjoy and positively evaluate multimedia experiences yet fail to internalize the academic content at a level reflected in performance assessments, demonstrating that emotional engagement and cognitive learning are distinct dimensions of multimedia effectiveness that do not automatically reinforce each other. This findings are evidenced by the following synthesized results:

Interactive multimedia-based e-modules produced only a medium N-Gain of 0.51, indicating that even positively received multimedia tools do not reliably achieve high cognitive learning gains, particularly when the intervention is brief and the sample is small. (Alyusfitri et al., 2024)

Combining a positive pedagogical agent with positive learning materials ameliorated learners' overall emotional experience but did not significantly affect retention and transfer performance, revealing a performance plateau where emotional engagement fails to translate into cognitive gains. (Lang et al., 2025)

Long-term vocabulary retention declined after seven days despite high student satisfaction, demonstrating that positive emotional responses to multimedia do not guarantee sustained cognitive retention. (Thangprasert et al., 2025)

The complexity of motivational and cognitive outcomes in multimedia learning challenges the assumption that learner satisfaction and enjoyment are sufficient indicators of effective instruction. Lang et al.'s (2025) experimental finding that positive pedagogical agents improved emotional experience without improving retention and transfer performance provides direct evidence of the performance plateau effect, where affective enhancements reach a ceiling beyond which further emotional improvements do not produce corresponding cognitive gains. Thangprasert et al.'s (2025) vocabulary retention data further illustrate that the positive

emotional responses generated by multimedia instruction do not guarantee durable memory encoding without deliberate instructional scaffolding for long-term retention.

These experiences are consistent with educational psychology literature distinguishing between intrinsic motivation, which drives self-directed engagement and sustained learning, and extrinsic or novelty-based motivation, which produces short-term enjoyment without deep cognitive processing. While emotional design elements can reduce academic anxiety and increase initial engagement, they cannot substitute for the deliberate cognitive demands reflection prompts, spaced practice, retrieval exercises that produce durable learning. Lauc, Jagodić, and Bistrović (2020) found that multimedia introductory activities were perceived as significantly more interesting than traditional methods and led to improved short-term assessment performance, yet acknowledged that motivational gains did not necessarily indicate sustained cognitive achievement directly confirming that emotional design must be paired with sound instructional scaffolding to produce measurable learning outcomes.

The implication of these findings is that emotionally appealing multimedia designs, while effective in increasing learners' motivation and enjoyment, do not automatically lead to improved cognitive performance or long-term learning. Positive emotional responses such as interest and satisfaction may enhance engagement, but they do not guarantee deeper understanding, retention, or transfer of knowledge. This implication highlights that emotional design elements must be balanced with cognitively demanding instructional features that promote active processing and meaningful learning. Supporting this implication, studies have shown that although multimedia tools can improve learner motivation, these affective gains do not necessarily translate into higher academic performance without deliberate instructional scaffolding (Hall, 2024; Lang et al., 2025; Christodoulou et al., 2024).

Teachers and multimedia developers should combine engaging visual and emotional design with cognitively focused strategies such as reflection prompts, retrieval practice, and spaced learning activities. Evaluating multimedia tools based on their impact on learning performance rather than learner satisfaction can help ensure that multimedia instruction produces meaningful academic gains (Lang et al., 2025; Christodoulou et al., 2024).

Multimedia Motivation Is Not Sustained Beyond the Classroom. The motivational benefits generated by multimedia tools often proved temporary, fading as the novelty of the technology diminished or when learners left the structured classroom environment. Their narratives revealed that multimedia's capacity to inspire initial enthusiasm and engagement does not automatically translate into sustained academic interest, self-regulated learning habits, or long-term motivational persistence particularly when the multimedia experience is brief, isolated from ongoing curricular engagement, or unsupported by parental and community follow-through. The following synthesized findings provide evidence for this pattern:

360° videos, printed materials, and web pages were all perceived as equally motivating; the motivational advantage of multimedia was not sustained as a distinct or superior force over conventional tools, suggesting that novelty-driven engagement is limited in duration. (Fokides & Arvaniti, 2020)

The YouTube video intervention lasted only four weeks and the long-term impact on student knowledge and motivation was not assessed, indicating that short-term multimedia exposure may not produce sustained motivational or cognitive outcomes. (Koto, 2020)

Despite high N-Gain effectiveness scores, the literacy intervention faced varying levels of student readiness and a persistent lack of parental supervision, limiting the sustainability of literacy gains outside the classroom environment. (Nurmaelinda & Jesicha, 2025)

The temporal limitations of novelty-based multimedia motivation are reflected across these accounts. Fokides and Arvaniti's (2020) finding that 360° video's motivational advantage over conventional tools was not sustained over time demonstrates that the initial excitement generated by technologically advanced multimedia does not produce lasting motivational differentiation. Koto's (2020) acknowledgment that a four-week YouTube video intervention was insufficient to assess long-term impact reveals a critical research and practice gap. Most multimedia interventions are too brief to produce or measure the sustained motivational and cognitive outcomes that evidence-based instructional policy requires.

The psychological distinction between situational interest the immediate, context-dependent engagement generated by novel or stimulating stimuli and individual interest the stable, internalized motivation that sustains long-term academic engagement frames these findings. Multimedia tools are particularly effective at generating situational interest but are insufficient on their own to develop individual interest without deliberate instructional strategies that connect multimedia experiences to learners' personal goals, cultural identities, and prior knowledge. Wherein, Hall (2024) acknowledged that high student motivation following video-based instruction did not correlate directly with actual academic performance gains.

The implication of these findings is that the motivational effects of multimedia tools are often temporary and largely driven by novelty rather than sustained academic interest. While multimedia can initially increase learners' engagement and enthusiasm, this motivation tends to decline when the novelty fades or when learning is no longer supported by structured classroom guidance. This implication indicates that multimedia alone cannot sustain long-term learner motivation or self-regulated learning without continuous instructional support and reinforcement beyond the classroom. Studies confirm that multimedia-generated interest often improves short-term engagement but does not necessarily lead to lasting motivation or academic performance without sustained instructional and social support (Fokides & Arvaniti, 2020; Lauc et al., 2020).

Teachers and schools should integrate multimedia consistently within the curriculum and connect it to learners' interests, goals, and home support systems. Strengthening parental involvement and regularly updating multimedia activities can help sustain learner motivation and transform short-term engagement into long-term learning interest (Wan Norudin et al., 2024; Dacoycoy et al., 2023; Fokides & Arvaniti, 2020).

Multimedia Tools Relevant and Appropriate for the Different Developmental Stages

The positive effect reveals the multimedia tools that are most relevant and appropriate for each developmental stage of elementary learners. Across the reviewed studies, multimedia tools are shown to serve as effective developmental scaffolds when they are matched to learners' cognitive, linguistic, and sociocultural readiness. The identified sub-themes, organized by developmental stage, include: (1) Imitative Play-Based Learning Stage (Ages 4–6 / Kindergarten), (2) Cultural Meaning-Making Learning Stage (Ages 6–8 / Grades 1–2), (3) Scaffolded Exploratory Learning Stage (Ages 8–10 / Grades 3–4), and (4) Self-Directed Inquiry Learning Stage (Ages 10–12 / Grades 5–6), collectively demonstrate that the deliberate selection of developmentally appropriate multimedia tools in elementary education carries significant benefits for learning outcomes.

Imitative Play-Based Learning Stage (Ages 4–6 / Kindergarten). At the earliest stage of formal education, the primary contribution of multimedia lies in its capacity to provide replicable visual models that facilitate skill acquisition through observation and imitation. In this developmental domain, multimedia tools act as external mediators that bridge the gap between a child's current physical and cognitive capacities and the foundational competencies they are developing. The two most appropriate and effective multimedia formats at this stage are Movement-Based Instruction Videos and Digital Vocabulary Learning Tools, as studies show that video-based modeling improves motor skills and early literacy outcomes, while interactive and audiovisual tools enhance phonological awareness, vocabulary acquisition, and engagement among young learners. These findings demonstrate that multimedia supports imitation, repetition, and sensory-based learning processes essential in early childhood development, making it highly effective when aligned with play-based and developmentally appropriate instructional approaches (Mohammad & Boushehry, 2023; Sibulo, 2025; Miranda, 2025; Rahmah, 2025; Herman et al., 2025; Zhang, 2024). The following synthesized findings offer evidence in support of this:

Movement-Based Instruction Video. This refers to a type of multimedia tool that uses video demonstrations to model physical actions, allowing young learners to observe, imitate, and practice movements in a structured and engaging way. According to the studies discussed, these videos typically present step-by-step demonstrations of physical activities such as basic motor skills (e.g., jumping, balancing, stretching, and coordination exercises), which children can replicate in real time. In the context of early childhood learning (Ages 4–6), these videos function as visual and behavioral models that support skill acquisition through imitation an essential developmental process at this stage. For example, the blended video-based instruction in kindergarten physical education significantly improved children's basic movement skills compared to traditional methods. This indicates that when learners repeatedly watch and follow guided movements, they develop coordination, body

awareness, and confidence more effectively. At this imitative play-based stage, video provides young learners with a replicable visual model of movement, consistent with the principle that children learn through observation of a more capable other in a shared activity context (Mohammad & Boushehry, 2023). The effectiveness of this approach is further substantiated by the following synthesized findings:

Instructional video used in kindergarten physical education through blended teaching consistently increased basic movement skills across all measured categories in the experimental group (n=40), providing young learners with a replicable visual model of movement. (Mohammad & Boushehry, 2023)

Audiovisual materials positively influenced kindergarten learners' reading readiness, producing significant improvements after implementation, and AR-based storytelling activities for children aged five to six significantly improved social skills compared to conventional learning activities. (Sibulo, 2025; Herman et al., 2025)

Instructional video used in kindergarten physical education through blended teaching consistently increased basic movement skills across all measured categories in the experimental group (n=40), providing young learners with a replicable visual model of movement consistent with the principle that children learn through observation of a more capable other in a shared activity context. (Mohammad & Boushehry, 2023)

Movement-based instructional video is an appropriate and effective multimedia tool for young learners at the kindergarten stage, particularly for scaffolding physical and movement-based skill acquisition. Mohammad and Boushehry's (2023) experimental evidence demonstrates that instructional video scaffolds motor skill development by providing the repetitive visual modeling that young children require to observe and internalize physical movement patterns. Sibulo's (2025) finding that audiovisual materials positively influenced reading readiness further confirms that the benefits of video-based modeling at this stage extend beyond physical skills to foundational literacy preparation.

The findings imply that movement-based instructional video functions as an effective mediating cultural tool that supports early skill acquisition when aligned with learners' developmental stage and embedded within social learning contexts. The effectiveness of video as a scaffolding mechanism is corroborated by studies showing that multimedia enhances comprehension, engagement, and performance by providing visual and contextual support (Cruz et al., 2023; Nuqui, 2021; Husna & Bentri, 2025).

Furthermore, the implication extends to the necessity of developmentally appropriate multimedia selection, as highlighted in the RRL section on multimedia types. Early learners benefit most from sensory-rich and visually guided tools such as instructional videos and audiovisual materials. This confirms that movement-based video is not only effective but also developmentally aligned with kindergarten learners' need for concrete, observable experiences (Sibulo, 2025; Miranda, 2025; Rahmah, 2025).

Educators should utilize video-based modeling to scaffold physical skill acquisition, as the repetitive nature of video allows young children to internalize motor patterns at their own pace. Studies confirm that movement-based instructional video produces the strongest outcomes when it is integrated within blended instructional designs that combine digital visual modeling with shared social interaction rather than isolated screen time (Baltzaki & Chlapana, 2023; Sibulo, 2025; Rahmah, 2025).

Digital Vocabulary Learning Tool. This refers to multimedia-based applications or resources that use interactive, visual, and auditory elements to support young learners in acquiring new words and language skills. According to the studies discussed, these tools typically include features such as animated visuals, audio pronunciation, repetition, and interactive activities (e.g., matching, naming, or listening tasks) that help children connect words with meanings in a meaningful and engaging way.

In the early childhood stage (Ages 4–6), these tools function as language scaffolds by providing concrete and multisensory representations of vocabulary, which are essential for learners who are still developing their linguistic and cognitive abilities. For instance, studies such as Sibulo (2025) and Miranda (2025) showed that audiovisual and animated multimedia significantly improved learners' phonological awareness, letter recognition, and early vocabulary development. Similarly, Zhang (2024) emphasized that culturally relevant

multimedia enhances comprehension by making vocabulary more meaningful and relatable to learners' experiences, while Rahmah (2025) found that interactive game-based media improved language-related understanding through active engagement. These outcomes are evidenced by the following synthesized findings:

ICT-assisted vocabulary instruction effectively developed receptive vocabulary in 48 kindergarten children aged five to six, with the blended approach producing the strongest gains by combining digital tools with shared, playful social interaction. (Baltzaki & Chlapana, 2023)

Letter recognition scores significantly increased among preschoolers using PowerPoint media, and multimedia-based strategies produced highly significant improvements across five cognitive dimensions related to multicultural cognition in preschool children. (Miranda, 2025; Zhang, 2024)

Digital Learning Materials were most effective when facilitating multisensory engagement and student collaboration, and interactive multimedia significantly improved early reading skills in Grade 1 students in remote schools. (Aligo & Prudente, 2025; Pujiariani & Cathrin, 2025)

Smart Box game media had a statistically significant positive effect on numeracy skills in children aged five to six, and AR-based storytelling activities significantly improved social skills compared to conventional learning activities, confirming that interactive and immersive digital media are developmentally appropriate formats for the kindergarten stage. (Rahmah, 2025; Herman et al., 2025)

Digital vocabulary learning tools are developmentally appropriate and effective for kindergarten learners when they combine digital engagement with social interaction in a blended instructional design. Baltzaki and Chlapana's (2023) finding that the blended ICT approach outperformed exclusive ICT use reveals that the social dimension of multimedia use is a critical determinant of effectiveness at the youngest learning stages: digital vocabulary tools are most powerful when they function as shared mediating instruments within face-to-face social contexts rather than as standalone digital activities.

The convergence of these findings confirms that movement-based instructional video and digital vocabulary learning tools are the most developmentally appropriate multimedia formats for kindergarten learners. Mohammad and Boushehry's (2023) experimental evidence demonstrates that instructional video scaffolds motor skill development by providing the repetitive visual modeling that young children require to observe and internalize physical movement patterns. Baltzaki and Chlapana's (2023) finding that the blended ICT approach outperformed exclusive ICT use further reveals that the social dimension of multimedia use is a critical determinant of effectiveness at the youngest learning stages: digital tools are most powerful when embedded within shared, playful social interaction rather than used in isolation.

The implication of these findings is that educators should utilize video-based modeling to scaffold physical skill acquisition and should prioritize blended digital vocabulary tools that encourage social interaction rather than isolated screen time. Movement-based instructional video provides the visual modeling and repetitive demonstration that young learners require to imitate and internalize motor and procedural skills, while digital vocabulary learning tools are most effective when they combine digital engagement with social interaction within a blended instructional design. Studies confirm that multimedia tools at this stage produce the strongest outcomes when they function as social mediators embedded in shared learning activity rather than as independent instructional technologies (Baltzaki & Chlapana, 2023; Aligo & Prudente, 2025).

Educators should prioritize blended digital vocabulary tools that encourage social interaction rather than isolated screen time to maximize language development. Studies confirm that digital vocabulary learning tools at this stage produce the strongest outcomes when they combine multisensory digital engagement with the social scaffolding provided by shared, playful interaction between learners and between learners and their teachers (Aligo & Prudente, 2025; Baltzaki & Chlapana, 2023).

Cultural Meaning-Making Learning Stage (Ages 6–8 / Grades 1–2). As learners transition into the primary grades, the role of multimedia shifts toward anchoring foundational literacy and concept formation within their lived sociocultural experiences. Multimedia tools at this stage function as culturally resonant scaffolds that make abstract content accessible by situating it within familiar narrative and cultural contexts. The two most

appropriate and effective multimedia formats at this stage are Culturally Situated Educational Videos and Narrative Picture Story Books. These findings confirm that multimedia grounded in learners' sociocultural contexts facilitates deeper understanding and supports early literacy by promoting meaningful and relatable learning experiences (Zhang, 2024; Pujiariani & Cathrin, 2025; Turmudli et al., 2025; Nurmaelinda & Jesicha, 2025; Parraga Lino & Tomala Chavez, 2025). This was evidenced by the following synthesized findings:

Culturally Situated Educational Video. This refers to a type of multimedia tool that presents instructional content through videos that reflect the learners' cultural background, language, daily experiences, and social context. According to the studies discussed, these videos are intentionally designed to make learning more meaningful by embedding academic concepts within familiar cultural settings, stories, or real-life situations that learners can easily relate to. t the Grades 1–2 level (Ages 6–8), these videos function as sociocultural scaffolds that support meaning-making by connecting new information to learners' prior knowledge and lived experiences.

For instance, Zhang (2024) found that culturally relevant multimedia significantly improved preschool learners' conceptual understanding and cognitive development because the content resonated with their cultural context. Similarly, Parraga, et al., (2025) showed that cartoon and narrative-based videos increased comprehension and motivation among young learners, indicating that culturally familiar and engaging formats enhance understanding. These findings suggest that when learners see their own culture, language, and experiences represented in multimedia, they are more able to interpret, internalize, and apply new knowledge.

Video lessons used as mass media produced positive results for Grade 2 at-risk children's reading and comprehension during the pandemic (n=23), supporting early literacy through accessible, culturally situated multimedia learning. (Ocampo, 2022)

Cocomelon videos significantly improved English language learning for 12 Grade 1 Teduray learners, with all scores rising from poor/very poor to average across phonology, vocabulary, and pronunciation (t-values: −8.42 to −13.00), confirming that culturally resonant video mediates foundational language learning by anchoring content in familiar sociocultural contexts. (Untong, 2025)

Ethnomathematics-based learning videos for Grade 1 achieved high feasibility ratings across all expert and student evaluations (material experts: 93.75%; design experts: 100%; media experts: 95%; individual trial: 92.36%; small group: 93.05%), confirming that videos embedding local cultural knowledge situate mathematical concepts within young learners' lived sociocultural experience. (Yandani & Agustika, 2022)

Integrating picture story books across Grades 1–6 demonstrated high effectiveness (average N-Gain = 0.82, 81.74%), with students reporting a 20% increase in imagination and creativity and a marked reduction in boredom, confirming that narrative picture story books are among the highest-effect multimedia tools documented in early literacy research. (Nurmaelinda & Jesicha, 2025)

Video lessons used as mass media produced positive results for Grade 2 at-risk children's reading and comprehension during the pandemic (n=23), supporting early literacy through accessible, culturally situated multimedia learning (Ocampo, 2022).

Culturally situated educational video is a particularly appropriate and effective multimedia format for learners in the Grades 1–2 stage, where language acquisition and foundational concept formation are anchored in familiar sociocultural contexts. Untong's (2025) dramatic improvements across phonology, vocabulary, and pronunciation among Teduray learners demonstrate that video's effectiveness at this stage is significantly amplified when its content is culturally resonant and linguistically accessible.

Yandani and Agustika's (2022) expert validation ratings confirm that videos deliberately embedding local cultural knowledge earn the highest levels of both expert and student approval because they situate academic concepts within contexts that are immediately meaningful to learners.

The convergence of these findings confirms that culturally situated educational video and narrative picture story books are the most developmentally appropriate multimedia formats for Grades 1–2 learners. Untong's (2025) dramatic improvements across phonology, vocabulary, and pronunciation among Teduray learners demonstrate

that video's effectiveness at this stage is significantly amplified when its content is culturally resonant, linguistically accessible, and anchored in the learners' own sociocultural context. Nurmaelinda and Jesicha's (2025) N-Gain score of 0.82, among the highest documented in the multimedia education literature, confirms that narrative picture story books produce exceptional learning outcomes for early readers because they simultaneously engage visual literacy, imagination, and comprehension development.

The implication of these findings is that multimedia developers should design content reflecting learners' local cultural and linguistic contexts to improve conceptual accessibility, and that teachers should integrate visually rich narrative scaffolds into literacy lessons to enhance engagement and comprehension. Culturally situated educational video simultaneously addresses linguistic accessibility, cultural relevance, and foundational concept formation for Grades 1–2 learners, while narrative picture story books remain among the most powerful visual literacy tools available for early primary instruction. Studies confirm that multimedia tools at this stage are most effective when they function as culturally resonant bridges connecting abstract academic content to learners' lived sociocultural experiences (Ocampo, 2022; Yandani & Agustika, 2022; Aligo & Prudente, 2025).

Multimedia developers should design content reflecting learners' local cultural and linguistic contexts to improve conceptual accessibility. Culturally situated educational video simultaneously addresses linguistic accessibility, cultural relevance, and foundational concept formation for Grades 1–2 learners. Studies confirm that culturally resonant video is most effective at this stage when it anchors abstract academic content within familiar sociocultural narratives that learners can connect to their own lived experiences (Ocampo, 2022; Untong, 2025; Aligo & Prudente, 2025).

Narrative Picture Story Book. Narrative picture story books represent one of the most developmentally appropriate and cognitively effective multimedia tools for elementary learners, particularly across the early and middle grades. Unlike traditional text-based materials, narrative picture story books combine visual storytelling, structured narrative flow, and emotional engagement, enabling learners to construct meaning more actively while maintaining high levels of motivation. The reviewed studies consistently revealed that this type of multimedia not only improves literacy-related outcomes but also stimulates imagination, creativity, and learner engagement. This was supported by the following synthesized findings:

Picture story books achieved an N-Gain score of 0.82 (81.74%, high effectiveness) across Grades 1–6, with students reporting a 20% increase in imagination and creativity and a marked reduction in boredom, confirming narrative picture story books as one of the highest-effect multimedia formats documented for early learners. (Nurmaelinda & Jesicha, 2025)

Visual literacy-based learning media for second-grade writing instruction achieved expert validity scores, confirming that visually rich, narrative-based multimedia tools earn high expert validation, and picture storybook learning media met quality, practicality, and effectiveness criteria for supporting fifth-grade students' critical and creative thinking. (Turmudli, Sumarno & Buchori, 2025; Gunawan, Suhardi & Makawawa, 2023)

Animated video stories significantly improved Grade 3 learners' story writing skills across all five writing domains. (Samosa et al., 2021)

Narrative picture story books function as powerful mediational tools because they support both cognitive and emotional dimensions of learning simultaneously. The high N-Gain score of 0.82 reported by Nurmaelinda and Jesicha (2025) indicates not only significant academic improvement but also meaningful affective outcomes, particularly increased imagination and creativity and reduced boredom. These outcomes are especially important for elementary learners, whose engagement and motivation strongly influence literacy development. The consistent reduction in boredom across Grades 1–6 also suggests that narrative-based multimedia maintains learner attention more effectively than traditional text-only materials, making it one of the most sustainable multimedia tools for long-term classroom use.

The effectiveness of narrative picture story books is also strongly supported by visual literacy research. Turmudli, Sumarno, and Buchori (2025) demonstrated that visually structured narrative media significantly improved second-grade writing skills by helping learners organize ideas more clearly. Similarly, Gunawan,

Suhardi, and Makawawa (2023) found that picture storybook learning media met all quality, practicality, and effectiveness standards while also improving critical and creative thinking among Grade 5 learners. These findings indicate that narrative picture story books are not limited to early literacy development; rather, they continue to support higher-order thinking skills as learners progress to higher grade levels.

The reviewed studies clearly demonstrate that narrative picture story books are one of the most effective multimedia tools for improving learner engagement, creativity, and academic performance in elementary education. Their ability to combine images, narratives, and meaningful learning experiences makes them highly suitable for young learners. Therefore, integrating narrative picture story books into reading, writing, and language instruction can significantly improve students' interest in learning while also strengthening their literacy and higher-order thinking skills (Nurmaelinda & Jesicha, 2025; Turmudli et al., 2025; Gunawan et al., 2023; Samosa et al., 2021).

The implication of these findings is that multimedia functions as an effective developmental scaffold for literacy learning in elementary education. The consistent improvements in listening, reading, and writing skills indicate that multimedia-supported instruction strengthens multiple literacy dimensions simultaneously by providing visual, auditory, and contextual support that facilitates comprehension, creative expression, and narrative development. This implication is supported by Turmudli, Sumarno, and Buchori (2025), who reported that visual literacy–based learning media for second-grade writing achieved high expert validity scores, confirming that developmentally appropriate multimedia tools can effectively strengthen early literacy across grade levels. Similarly, Dong et al. (2024) found that interactive visual multimedia technology significantly improved literacy skills among children in rural contexts, highlighting the importance of multimedia in supporting equitable literacy development for learners in resource-limited environments.

Schools should prioritize the use of narrative picture story books as a developmentally appropriate and highly effective multimedia tool for elementary learners (Nurmaelinda & Jesicha, 2025; Turmudli et al., 2025; Gunawan et al., 2023).

Scaffolded Exploratory Learning Stage (Ages 8–10 / Grades 3–4). For learners in the middle elementary years, multimedia's value lies in its ability to provide structured representations of disciplinary content and complex narrative structures. During this stage, multimedia tools evolve into more sophisticated mediating instruments that support the transition from learning to read to more academic reading to learn. The most appropriate and effective multimedia formats at this stage include Subject-Specific Instructional Video Clips, Story-Based Animated Video, Collaborative Project-Based Video, Interactive Reflection Video Modules, Multi-Element Digital Media, and Immersive 360° Video. Evidence from the reviewed studies demonstrates that video-based instruction improves conceptual understanding, animated and narrative multimedia enhance reading comprehension and writing skills, collaborative video tasks strengthen social learning and communication, and interactive or immersive multimedia environments foster critical thinking and engagement when supported by reflective prompts and guided instruction (Hsu et al., 2022; Özdemir et al., 2025; Alyusfitri et al., 2024; Febiyanti et al., 2021; Wan Norudin et al., 2024; Villena-Taranilla et al., 2022; Fokides & Arvaniti, 2020). This is substantiated by the following integrated results:

Subject-Specific Instructional Video Clip. This refers to a type of multimedia tool that delivers focused academic content through short, structured videos designed for a particular subject area such as Mathematics, Science, or Language. According to the studies discussed, these video clips present concepts through clear explanations, visual demonstrations, and guided examples, allowing learners to better understand abstract or complex topics. At the Grades 3–4 level (Ages 8–10), these videos function as cognitive scaffolds that support learners in transitioning from basic comprehension to deeper conceptual understanding. For instance, Lagua (2024) found that video clips significantly improved students' mastery of weather concepts, with learners progressing from low to mastered levels. Similarly, Koto (2020) reported that YouTube-based instructional videos enhanced students' procedural knowledge in science, while Husna and Bentri (2025) showed that video-supported mathematics instruction improved engagement and understanding of abstract concepts. These findings indicate that subject-specific video clips help break down complex ideas into manageable and visually supported segments, making them easier for learners to process and apply. This was anchored by the following evidence:

Video clips significantly improved Grade 4 students' understanding of weather elements, moving from low to mastered in the post-test with a large positive effect size. (Lagua, 2024)

Video-clip instruction significantly improved Grade 6 pupils' English performance, with the experimental group achieving excellent post-test results compared to pre-test moderately effective levels, and audio-video lessons significantly improved Grade 3 pupils' English performance, advancing students from fair to satisfactory levels. (Ampuyos & Villaruz, 2022; Nuqui, 2021)

Video lessons were evaluated as very satisfactory in content, instructional, and technical quality with students exhibiting high motivation, and combining a Realistic Mathematics Education model with learning videos significantly affected student achievement. (Hall, 2024; Husna & Bentri, 2025)

Animated video stories significantly improved Grade 3 learners' story writing skills across all five writing domains, and multimedia animation with audio narrations or subtitles was significantly more effective than traditional instruction in reading comprehension and motivation among 100 Grade 4 students, mitigating the negative impact of text difficulty and functioning as a cognitive scaffold for learners transitioning from learning to read to reading to learn. (Samosa et al., 2021; Özdemir, Karaçoban & Efendioglu, 2025)

Subject-specific instructional video clips are highly effective and developmentally appropriate multimedia formats for learners in the Grades 3–4 scaffolded exploratory stage. Lagua's (2024) large effect size demonstrates that targeted video instruction produces the specific visual mediation needed for abstract disciplinary content at this stage, enabling learners to move from low to mastered performance within a single instructional cycle. The convergence of Ampuyos and Villaruz's (2022) and Nuqui's (2021) findings across English language learning further confirms that subject-specific video clips are consistently effective across disciplinary domains and grade levels within the Grades 3–4 range.

The findings imply that subject-specific instructional video clips serve as powerful cognitive and mediating tools that facilitate learners' transition from concrete to more abstract understanding during the exploratory stage. This confirms that subject-specific video clips are not only effective but necessary for scaffolding learning across different academic domains. Multimedia tools are most effective when they are carefully matched to learners' developmental stage and subject matter, particularly for lower elementary learners who benefit from visual and interactive supports in building conceptual understanding (Pujiariani & Cathrin, 2025; Turmudli et al., 2025; Oktania et al., 2025).

Schools should implement targeted video instruction for abstract subjects to provide the necessary visual mediation for scientific and linguistic processes. Studies confirm that subject-specific instructional video clips produce the strongest outcomes when they are matched precisely to the disciplinary content learners are studying, used as primary rather than supplementary instructional tools, and paired with structured comprehension tasks that require active processing of video content (Husna & Bentri, 2025; Hall, 2024).

Story-Based Animated Video. Animated video stories significantly improved Grade 3 learners' story writing skills across all five writing domains, with a statistically significant pretest-to-posttest difference. Story-based animated video leverages learners' developing capacity to process sequential visual-aural narrative as a scaffolded mediating tool for early composition (Samosa et al., 2021). These were reflected in the following results:

Animated video stories significantly improved Grade 3 learners' story writing skills across all five writing domains, with a statistically significant pretest-to-posttest difference. (Samosa et al., 2021)

Multimedia animation with audio narrations or subtitles was significantly more effective than traditional instruction in reading comprehension and motivation among 100 Grade 4 students, mitigating the negative impact of text difficulty and functioning as a cognitive scaffold for learners transitioning from learning to read to reading to learn. (Özdemir, Karaçoban & Efendioglu, 2025)

Comic media had a statistically significant effect on third-grade students' critical thinking, and cartoon videos were highly effective in facilitating English listening comprehension, further confirming the effectiveness of

visual-narrative multimedia across writing, reading, and listening domains. (Pratiwi & Rezania, 2024; Parraga Lino & Tomala Chavez, 2025)

Story-based animated video is a developmentally appropriate and effective multimedia format for Grades 3–4 learners, particularly for supporting writing and reading comprehension at the transitional stage where children are moving from learning to read to reading to learn. Samosa et al.'s (2021) improvements across all five writing domains confirm that animated narrative video scaffolds writing development by providing learners with visual-aural representations of story structure that they can observe, internalize, and replicate in their own compositions. Özdemir, Karaçoban, and Efendioglu's (2025) finding that animated multimedia with audio narrations mitigated the negative impact of text difficulty further reveals that story-based animation is particularly powerful for supporting struggling readers at this transitional stage.

Teachers should utilize animated narratives to contextualize abstract language concepts, allowing students to internalize storytelling structures through visual and auditory cues. Studies confirm that story-based animated video produces its strongest outcomes when it simultaneously scaffolds both reading comprehension and writing development by providing the visual-aural representations of narrative structure that Grades 3–4 learners need as they transition from foundational to more academic literacy (Samosa et al., 2021; Özdemir, Karaçoban & Efendioglu, 2025).

Collaborative Project-Based Video. Project-based learning videos significantly improved fourth-grade students' listening comprehension during the pandemic. Collaborative project-based video enables group-based viewing, discussion, and task completion, reinforcing the emphasis on social interaction as the driver of cognitive development (Febiyanti et al., 2021). This is authenticated by the following aggregate studies:

Project-based learning videos significantly improved fourth-grade students' listening comprehension during the pandemic, with post-test mean scores of 86.85 compared to pre-test scores of 75.75 at a significance level of .000, enabling group-based viewing, discussion, and task completion. (Febiyanti et al., 2021)

Differentiated multimedia-assisted instruction significantly improved writing performance of 82 EFL elementary students, promoting collaborative meaning-making, and active engagement with reading-related activities rather than passive exposure significantly improved reading comprehension, confirming that multimedia tools produce their strongest outcomes when they require active collaborative engagement. (Wan Norudin et al., 2024)

Interactive digital media significantly improved fourth-grade students' history comprehension and engagement, and teachers should implement project-based learning models where students work in teams to produce video content, thereby internalizing academic material through social construction. (Asbah, Firdaus & Fathurrohman, 2025; Almacen & Labitad, 2024)

Collaborative project-based video is a particularly appropriate and effective multimedia format for Grades 3–4 learners, where cooperative learning and group-based task completion are emerging as critical components of academic development. Febiyanti et al.'s (2021) significant improvement in listening comprehension scores demonstrates that the combination of video content with collaborative group tasks produces strong academic outcomes because it leverages the social construction of knowledge that is characteristic of this developmental stage. Wan Norudin et al.'s (2024) confirmation that active engagement rather than passive exposure produces the strongest comprehension gains further underscores that collaborative project-based video is most effective when it demands genuine collaborative engagement from learners rather than passive co-viewing.

Teachers should implement project-based learning models where students work in teams to produce or engage with video content, thereby internalizing academic material through social construction. Studies confirm that collaborative project-based video produces its strongest outcomes when it integrates group-based task demands with video content in a design that requires learners to actively discuss, analyze, and produce knowledge together rather than simply viewing multimedia as a class (Febiyanti et al., 2021; Herman et al., 2025; Almacen & Labitad, 2024).

Interactive Reflection Video Module. This refers to a multimedia tool that combines video-based instruction with embedded prompts, questions, or tasks that require learners to actively think, respond, and reflect while engaging with the content. According to the studies discussed, these modules go beyond passive viewing by integrating structured opportunities for learners to pause, analyze information, and construct their own understanding through guided reflection. At the Grades 3–4 level (Ages 8–10), these modules function as metacognitive scaffolds that support higher-order thinking skills such as analysis, evaluation, and reasoning. For example, Hsu et al. (2022) found that video-based learning systems with embedded Socratic reflection prompts significantly improved students' critical thinking and analytical abilities, as learners were required to interpret content, justify answers, and engage in deeper cognitive processing. This demonstrates that when reflection is intentionally integrated into multimedia, it transforms video from a passive instructional tool into an active learning experience. The following synthesized findings provide further evidence of this effect:

Socratic Reflection Prompts embedded in a video-based interactive module significantly improved critical thinking in Grade 4 students, with responding to prompts specifically enhancing analysis skills, confirming that interactive reflection modules engage learners at the upper boundary of their developing metacognitive capacities. (Hsu, Lin, Yeh & Chen, 2022)

Problem-based learning assisted by audiovisual tools significantly improved fifth-grade students' critical thinking, and a statistically significant effect of the Multi-Matobe model and comic media on third-grade students' critical thinking confirmed that multimedia tools incorporating structured reflection and problem-solving demands are effective for developing critical thinking across the upper elementary grades. (Yani, 2025; Pratiwi & Rezania, 2024)

Gamified instruction significantly improved reading comprehension among Grade 4 learners, and digital-based Smartbox media combined with problem-based learning improved cognitive mastery among fourth-grade students across instructional cycles, confirming that interactive digital tools broadly support higher-order literacy and cognitive skills at this stage. (Doria et al., 2025; Fitriyani, Nugroho & Febrianti, 2025)

Socratic Reflection Prompts embedded in a video-based interactive module significantly improved critical thinking in Grade 4 students, with responding to prompts specifically enhancing analysis skills, and 360° videos produced superior learning outcomes and a stronger sense of presence than printed materials and web pages for students aged 9–10 (n=44), confirming that both reflective and immersive multimedia formats are highly effective at this exploratory stage. (Hsu, Lin, Yeh & Chen, 2022; Fokides & Arvaniti, 2020)

Interactive reflection video modules are a developmentally appropriate and effective multimedia format for upper Grades 3–4 learners, where metacognitive development is beginning to emerge as a significant determinant of academic performance. Hsu et al.'s (2022) finding that Socratic reflection prompts specifically enhanced analysis skills confirms that the reflective and interactive dimensions of multimedia modules are the critical features that distinguish their effectiveness from passive video viewing at this stage. The interactive reflection module is appropriate because it engages learners at the upper boundary of their developing metacognitive capacities, requiring them to pause, reflect, and articulate their reasoning in response to disciplinary content rather than passively consuming information.

The findings imply that interactive reflection video modules function as advanced mediating tools that promote higher-order thinking and metacognitive development, particularly at the upper elementary stage. The implication underscores the importance of interactive and reflective multimedia design. Multimedia tools are most effective when they promote active participation, problem-solving, and cognitive engagement rather than passive consumption (Aligo & Prudente, 2025; Furenes et al., 2021). The effectiveness of Socratic prompts and problem-based multimedia supports existing findings that structured reflection and guided inquiry are critical in developing learners' analytical and evaluative skills (Yani, 2025; Pratiwi & Rezania, 2024).

Instructional designers should incorporate interactive prompts and reflection checkpoints within video modules to ensure active cognitive engagement and immediate feedback. Studies confirm that interactive reflection video modules produce the strongest critical thinking outcomes at the Grades 3–4 stage when they combine video's multimodal content presentation capacity with structured reflective demands that require learners to engage in

analysis, evaluation, and self-monitoring rather than passive information consumption (Hsu et al., 2022; Doria et al., 2025; Abdullah & Sadiah, 2025).

Multi-Element Digital Media. This refers to a type of multimedia tool that integrates multiple components such as text, images, audio, animation, and interactive features into a single learning environment to present content in a more comprehensive and engaging way. At the Grades 3–4 level (Ages 8–10), multi-element digital media functions as a cognitive scaffold that helps learners organize, connect, and apply information across different formats. For instance, Alyusfitri et al. (2024) found that interactive multimedia-based e-modules improved students' understanding of geometry concepts by combining visuals, explanations, and interactive tasks. Similarly, Özdemir et al. (2025) reported that multimedia materials with animation, audio narration, and text significantly enhanced reading comprehension by reducing the difficulty of complex texts. These findings indicate that combining multiple elements within a single platform supports both comprehension and higher-order thinking. The following synthesized findings further illustrate these benefits:

Multi-element multimedia improved reading comprehension significantly among 20 indigenous primary pupils through combined media scaffolding, with visual elements most effective and audio alone least effective, confirming that multi-element design produces stronger outcomes than single-channel presentations. (Samat & Aziz, 2020)

Full first-language captions in video media were most effective for vocabulary acquisition among intermediate EFL learners, illustrating that the modality-specific design of multi-element tools must be deliberately matched to specific language learning targets, and audiovisual exposure significantly outperformed non-captioned conditions in supporting grammar construction learning. (Hsieh, 2020; Pattemore & Muñoz, 2020)

Digital Learning Materials were most effective when facilitating multisensory engagement, confirming that multi-element instructional design integrating visual, auditory, and textual information simultaneously produces stronger learning outcomes than any single modality alone. (Aligo & Prudente, 2025)

Multi-element multimedia learning combining visual, audio, and text components improved reading comprehension among 20 indigenous primary pupils, with visual elements most effective and audio alone least effective, and project-based learning videos significantly improved fourth-grade students' listening comprehension during the pandemic (posttest mean: 86.85 vs. pretest: 75.75; Sig. = .000), confirming that multi-element and collaborative multimedia are highly appropriate formats for the Grades 3–4 stage. (Febiyanti et al., 2021)

Multi-element digital media combining visual, audio, and text components simultaneously is particularly effective for Grades 3–4 learners who are developing the cognitive capacity to process multiple information streams concurrently. Samat and Aziz's (2020) finding that visual elements were most effective while audio alone was least effective provides important design guidance for this stage: multi-element media must be deliberately designed so that visual and textual channels carry the primary informational load while audio serves a reinforcing rather than primary function. Hsieh's (2020) and Pattemore and Muñoz's (2020) findings that captioned and multi-modal conditions outperformed non-captioned conditions further confirm that the redundant encoding of information across multiple simultaneous channels is the critical design feature that produces multi-element media's superior outcomes.

The convergence of these findings confirms that a diverse range of multimedia formats spanning instructional video clips, animated narratives, collaborative project video, interactive reflection modules, multi-element digital media, and immersive 360° environments are all developmentally appropriate for Grades 3–4 learners, each addressing a distinct dimension of the scaffolded exploratory stage. Lagua's (2024) large effect size for video-clip instruction confirms that subject-specific video provides the visual scaffolding necessary for abstract disciplinary content at this stage. Hsu et al.'s (2022) finding that interactive reflection prompts specifically enhanced analytical skills demonstrates that multimedia is most powerful at this stage when it demands active cognitive engagement rather than passive consumption. Fokides and Arvaniti's (2020) superior learning outcomes for 360° video further confirm that immersive formats that situate learners in realistic sociocultural

environments produce particularly high levels of engagement and comprehension among nine- and ten-year-olds.

The implication of these findings is that schools should implement targeted video instruction for abstract subjects, utilize animated narratives to contextualize complex language concepts, and incorporate interactive prompts and reflection checkpoints within video modules to ensure active cognitive engagement. Instructional materials for middle elementary grades should employ a multi-element approach ensuring that audio narrations and visual cues work in tandem to reduce cognitive load, while educators should utilize immersive video technology to provide virtual field trips that allow students to explore sociocultural and scientific contexts supporting high-level engagement. Studies confirm that multimedia tools at this stage produce the strongest outcomes when they simultaneously scaffold comprehension, promote reflective thinking, and situate learning within authentic contexts (Hsu et al., 2022; Fokides & Arvaniti, 2020; Aligo & Prudente, 2025).

Instructional materials for middle elementary grades should employ a multi-element approach, ensuring that audio narrations and visual cues work in tandem to reduce cognitive load. Studies confirm that multi-element digital media produces its strongest outcomes at the Grades 3–4 stage when all modality channels are deliberately coordinated to provide redundant, mutually reinforcing representations of target content rather than presenting each modality independently (Aligo & Prudente, 2025; Samat & Aziz, 2020; Hsieh, 2020).

Self-Directed Inquiry Learning Stage (Ages 10–12 / Grades 5–6). As learners transition into the upper elementary years, the role of multimedia shifts toward supporting autonomous investigation and the development of higher-order cognitive and metacognitive capacities. Multimedia tools at this stage function as sophisticated inquiry scaffolds that enable learners to navigate complex information environments and engage in design-based digital creation. The most appropriate and effective multimedia formats at this stage are Discovery-Based YouTube Videos, Self-Directed Interactive E-Modules, Multimedia Vocabulary Tools, Affective Design Multimedia, and Creative 3D Modeling Tools. These were evidenced by the following synthesized findings, which demonstrate that multimedia supports independent learning, enhances higher-order thinking, and improves academic performance when aligned with learners' developmental readiness and supported by interactive and cognitively engaging design (Alyusfitri et al., 2024; Yonanda et al., 2024; Jalmasco et al., 2025; Hsu et al., 2022; Özdemir et al., 2025). This transition toward inquiry-based digital learning is supported by the following synthesized findings:

Discovery-Based YouTube Video. This refers to a type of multimedia tool that utilizes YouTube videos designed to promote inquiry-based learning through exploration, observation, and guided discovery. At the Grades 5–6 level (Ages 10–12), discovery-based YouTube videos function as cognitive and inquiry scaffolds that allow learners to engage with real-world contexts, analyze information, and construct understanding independently. For instance, Tran Thien (2022) found that YouTube video clips significantly improved learners' listening comprehension and fostered positive learning attitudes by presenting authentic and meaningful content.

Similarly, Koto (2020) reported that YouTube videos integrated with guided discovery learning improved students' procedural knowledge, demonstrating their effectiveness in supporting concept exploration. Furthermore, Hsu et al. (2022) showed that embedding reflective prompts within video-based learning enhanced learners' critical thinking and analytical skills, while Özdemir et al. (2025) found that multimedia video materials improved comprehension and reduced the difficulty of complex texts. These findings indicate that discovery-based YouTube videos support both independent inquiry and higher-order thinking when designed to encourage active engagement rather than passive viewing. These was evidenced by the following synthesized findings:

YouTube videos integrated with guided discovery learning significantly improved primary students' procedural knowledge of heat transfer, with the experimental group's gains substantially exceeding the control group's. (Koto, 2020)

Among fifth-grade students (n=42), discovery learning combined with YouTube video showed the most distinctive procedural knowledge gains compared to hands-on activities alone, and problem-based learning assisted by audiovisual tools significantly improved fifth-grade students' critical thinking. (Yani, 2025)

EcoQuest, an interactive digital story for Grade 6 ecosystem instruction, received high expert ratings and improved student engagement, and Articulate Storyline-based multimedia integrating PhET simulations, Quizizz, and live worksheets for fifth-grade science produced significant learning gains. (Jalmasco et al., 2025; Nurkhalimah & Andriani, 2025)

Discovery-based YouTube video is a particularly appropriate and effective multimedia format for learners at the Grades 5–6 self-directed inquiry stage. Koto's (2020) experimental evidence that discovery-based YouTube video substantially outperformed traditional instruction in procedural knowledge gains demonstrates that multimedia is most powerful at this stage when it functions as a scaffold for guided inquiry rather than a passive information channel. Koto's (2020) comparison of YouTube-integrated discovery learning with hands-on activities alone further confirms that video serves as a critical inquiry scaffold by enabling learners to observe complex scientific processes that would be difficult to replicate through physical manipulation alone.

The findings imply that interactive reflection video modules function as advanced mediating tools that promote higher-order thinking and metacognitive development, particularly at the upper elementary stage. the implication underscores the importance of interactive and reflective multimedia design. The RRL indicates that multimedia tools are most effective when they promote active participation, problem-solving, and cognitive engagement rather than passive consumption (Aligo & Prudente, 2025; Furenes et al., 2021). The effectiveness of Socratic prompts and problem-based multimedia supports existing findings that structured reflection and guided inquiry are critical in developing learners' analytical and evaluative skills (Yani, 2025; Pratiwi & Rezania, 2024).

These findings imply that interactive reflection video modules must be intentionally designed to integrate reflection, interaction, and guided inquiry, reinforcing the need for an evidence-based teaching primer that equips educators with strategies to effectively use multimedia for higher-order thinking development (Aligo & Prudente, 2025; May et al., 2024).

Teachers should curate YouTube content specifically for guided discovery activities, ensuring students use the video as a primary source for investigation. Studies confirm that discovery-based YouTube video produces its strongest outcomes when it is integrated within a structured inquiry framework that provides learners with guiding questions, investigation tasks, and opportunities for collaborative sense-making rather than used as a standalone viewing activity (Koto, 2020; Yani, 2025).

Self-Directed Interactive E-Module. This refers to a type of multimedia tool that integrates interactive digital components such as text, visuals, animations, and embedded tasks into a structured platform that learners can navigate independently. At the Grades 5–6 level (Ages 10–12), self-directed interactive e-modules function as autonomous learning environments that support self-paced learning, problem-solving, and metacognitive development. For instance, Alyusfitri et al. (2024) found that interactive multimedia-based e-modules significantly improved students' understanding of geometry concepts by combining explanations, visuals, and interactive activities within a single platform. Similarly, Yonanda et al. (2024) reported that interactive multimedia increased learners' motivation and overall learning outcomes, highlighting its effectiveness in promoting engagement and independent learning.

In addition, Jalmasco et al. (2025) found that digital platforms enhanced learners' conceptual understanding and engagement, particularly in tasks requiring higher-order thinking. These findings indicate that self-directed interactive e-modules support both academic achievement and learner autonomy by enabling active engagement, continuous feedback, and self-regulated learning. This was supported by the following synthesized findings:

Interactive multimedia-based e-modules significantly improved learning outcomes for 24 fifth-grade students in geometry (N-Gain = 0.51, 51%), with a strong correlation (rxy = 0.687) between student responses and outcomes. (Alyusfitri et al., 2024)

The interactive e-module for Grade 6 Earth Science passed all DepEd-LRMDS quality standards, validating self-directed interactive e-modules as effective mediating tools at this stage, and Articulate Storyline-based multimedia e-modules for fifth-grade science received high feasibility scores and produced significant learning gains. (Mijares III, 2023; Nurkhalimah & Andriani, 2025)

Multimedia-based interactive materials for fifth graders received 90% validity ratings and showed clear improvements in student motivation and achievement, and interactive learning media for Grade 6 significantly moved underperforming students toward meeting learning goals. (Yonanda et al., 2024; Indrawati, Hariani & Nimatullah, 2025)

Self-directed interactive e-modules are a highly appropriate and effective multimedia format for Grades 5–6 learners who possess the cognitive readiness and digital literacy to navigate complex, non-linear learning environments independently. Alyusfitri et al.'s (2024) strong correlation between student responses and learning outcomes confirms that learner agency and self-regulation are the critical mediating factors in e-module effectiveness at this stage: the more actively learners engage with the interactive elements of the module, the greater their learning gains. Mijares III's (2023) DepEd-LRMDS quality validation further confirms that self-directed e-modules can achieve the highest standards of instructional quality when they are designed to support independent, self-regulated learning.

The findings imply that self-directed interactive e-modules function as autonomy-supporting mediating tools that enhance learning outcomes by promoting self-regulation, learner agency, and independent knowledge construction among upper elementary learners. The implication highlights the importance of developmental readiness and digital competence in multimedia integration. The strong correlation between engagement and achievement corroborates studies indicating that multimedia enhances academic performance when learners actively interact with content and take control of their learning process (Cruz et al., 2023; Husna & Bentri, 2025).

Overall, these findings imply that self-directed interactive e-modules must be carefully designed to balance autonomy with guidance, reinforcing the need for an evidence-based teaching primer that supports teachers in facilitating self-regulated learning while ensuring accessibility, quality design, and effective implementation (Aligo & Prudente, 2025; May et al., 2024).

Schools should implement interactive e-modules for subjects requiring mastery-based progression, providing students with immediate feedback and branching paths. Studies confirm that self-directed interactive e-modules produce their strongest outcomes at the Grades 5–6 stage when they are designed to support genuine self-regulation by giving learners control over their learning pathways, providing immediate corrective feedback, and enabling mastery-based progression through content rather than time-based sequencing (Alyusfitri et al., 2024; Agno & Panoy, 2022; Nurkhalimah & Andriani, 2025).

Creative 3D Modeling Tool. This refers to a type of multimedia tool that enables learners to design, manipulate, and visualize three-dimensional objects in a digital environment, supporting hands-on, design-based learning experiences. At the Grades 5–6 level (Ages 10–12), creative 3D modeling tools function as constructivist and inquiry-based platforms that allow learners to apply concepts, explore spatial relationships, and engage in creative problem-solving. For instance, Sosna et al. (2025) found that 3D modeling tools enhanced learners' creativity and design thinking, as students actively constructed and visualized their ideas through digital models. Similarly, Mijares III (2023) reported that multimedia tools combining visual and interactive elements improved learners' conceptual understanding by allowing them to manipulate representations of abstract concepts. These findings indicate that creative 3D modeling tools support higher-order thinking and innovation by engaging learners in active creation and experiential learning processes rather than passive content consumption. This shift toward active creation is evidenced by the following synthesized findings:

3D modeling technology had a demonstrably positive effect on all four creativity components (fluency, flexibility, originality, and elaboration) in the experimental group among 160 elementary pupils, confirming that design-based digital creation tools are effective for developing multidimensional creativity at this stage. (Sosna, Vochozka, Šerý & Blažek, 2025)

EcoQuest, an interactive digital story using the Twine application for Grade 6 ecosystem instruction, produced improved engagement and high expert ratings, and AR-based applications significantly improved students' learning outcomes across content areas. (Jalmasco et al., 2025; Ibrahim et al., 2025)

Meta-analysis confirmed that VR significantly enhances K–6 student learning, with immersive, active experiences proving most effective, confirming that design-based and immersive digital creation tools support the development of creativity and higher-order thinking at the self-directed inquiry stage. (Villena-Taranilla et al., 2022)

Creative 3D modeling tools are an appropriate and effective multimedia format for Grades 5–6 learners who have developed the cognitive readiness and technical capacity for design-based digital creation. Sosna et al.'s (2025) finding that 3D modeling produced positive effects across all four creativity components confirms that design-based digital creation tools are uniquely effective at this stage for developing multidimensional creativity because they require learners to actively produce three-dimensional solutions to design challenges rather than passively consume or interact with existing digital content. The requirement to plan, iterate, and refine three-dimensional designs engages the full range of creative cognitive processes fluency, flexibility, originality, and elaboration that are characteristic of this self-directed inquiry stage.

The findings imply that creative 3D modeling tools function as high-level constructivist and mediating tools that promote creativity, innovation, and higher-order thinking through active knowledge production. The strong impact on creativity aligns with studies indicating that multimedia enhances not only comprehension but also higher-order cognitive processes when learners are engaged in active and immersive learning experiences (Husna & Bentri, 2025; Villena-Taranilla et al., 2022). Overall, these findings imply that creative 3D modeling tools must be embedded within well-designed, supportive learning environments that balance learner autonomy with instructional guidance, reinforcing the need for an evidence-based teaching primer that equips educators with strategies for integrating advanced multimedia tools to foster creativity and higher-order thinking (Aligo & Prudente, 2025; May et al., 2024).

Educators should integrate 3D modeling and augmented reality tools into STEM subjects to help students visualize and create solutions to complex problems. Studies confirm that creative 3D modeling tools produce their strongest outcomes at the Grades 5–6 stage when they are embedded within design-based learning frameworks that provide learners with authentic design challenges, iterative feedback cycles, and opportunities for creative risk-taking within a supportive instructional environment (Sosna et al., 2025; Ibrahim et al., 2025; Villena-Taranilla et al., 2022).

Affective Design Multimedia. This refers to a type of multimedia tool that is intentionally designed to influence learners' emotions, motivation, and engagement through elements such as visuals, color, audio, narrative, and user experience. At the Grades 5–6 level (Ages 10–12), affective design multimedia functions as a motivational scaffold that enhances emotional engagement and supports sustained attention in learning tasks. For instance, Hall (2024) found that video-based multimedia significantly increased learners' motivation and engagement, even when improvements in academic performance varied. Similarly, Lang et al., (2025) reported that multimedia tools enhanced emotional engagement, although this did not always translate into higher retention, highlighting the importance of affective factors in learning. These findings indicate that affectively designed multimedia plays a crucial role in maintaining learner interest, reducing cognitive barriers, and creating a positive learning experience that supports engagement and persistence in complex tasks. This impact was supported by the following synthesized findings:

Warm colors and anthropomorphic characters in multimedia reduced boredom and anxiety and increased enjoyment, intrinsic motivation, and mental effort in elementary science learners (n=203 and 140), with their combination facilitating retention and transfer performance, confirming that affective design elements produce measurable academic benefits beyond motivational effects alone. (Lang, Gong, Wu, Liu & Deng, 2025)

Video lessons were rated very satisfactory by Grade 6 learners in terms of content, instructional, and technical quality, and students exhibited high motivation following video-based instruction, and self-efficacy and interest mediate the relationship between mastery goals and academic performance in multimedia-assisted learning contexts. (Hall, 2024; Christodoulou et al., 2024)

Interactive tools like Wordwall and Quizizz significantly increased social studies learning motivation, and a performance plateau was observed in which emotional design improvements did not immediately produce better

academic results, confirming that affective multimedia design must be paired with sound instructional scaffolding and cognitive demands well-matched to learners' proficiency levels. (Tarishah & Yatri, 2025)

Affective design multimedia tools deliberately incorporating emotional design elements such as warm colors, anthropomorphic characters, and emotionally engaging visual features are an appropriate format for Grades 5–6 learners where motivational and emotional factors increasingly influence academic engagement. Lang et al.'s (2025) finding that warm colors and anthropomorphic characters produced measurable reductions in boredom and anxiety alongside increases in enjoyment and intrinsic motivation confirms that affective design elements have genuine pedagogical value at this stage by creating the emotional conditions necessary for sustained cognitive engagement. However, the finding that a performance plateau emerged when emotional design improvements were not matched by adequate instructional scaffolding reveals an important design constraint: affective design features are most effective when they are integrated within instructionally robust multimedia rather than added as cosmetic enhancements to otherwise weak instructional designs.

The convergence of these findings confirms that discovery-based YouTube video, self-directed interactive e-modules, multimedia vocabulary tools, affective design multimedia, and creative 3D modeling are the most developmentally appropriate formats for Grades 5–6 learners. Koto's (2020) experimental evidence that discovery-based YouTube video outperformed traditional instruction in procedural knowledge gains demonstrates that multimedia is most powerful at this stage when it functions as a scaffold for guided inquiry rather than a passive information channel. Alyusfitri et al.'s (2024) strong correlation between student responses and learning outcomes in interactive e-module use confirms that learner agency and self-regulation are the critical mediating factors at this developmental stage. McDonald et al.'s (2024) finding that English Learners benefited significantly more than non-EL peers from CAP-S vocabulary instruction further reveals that multimedia vocabulary tools at this stage serve a critical equity function by providing scaffolded academic language access for linguistically diverse learners.

The implication of these findings is that teachers should curate YouTube content specifically for guided discovery activities, schools should implement interactive e-modules for subjects requiring mastery-based progression, and vocabulary instruction should incorporate digital tools providing word meanings through multiple contexts visual, auditory, and textual to ensure durability in memory. Multimedia developers should deliberately incorporate positive emotional triggers in instructional design to foster a more receptive learning environment, and educators should integrate 3D modeling and augmented reality tools into STEM subjects to help students visualize and create solutions to complex problems. Studies confirm that multimedia tools at this stage produce the strongest outcomes when they support self-regulated inquiry, provide emotionally engaging design, and offer pathways for creative production alongside content mastery (Lang et al., 2025; Sosna et al., 2025; Agno & Panoy, 2022).

Multimedia developers should deliberately incorporate positive emotional triggers in instructional design to foster a more receptive learning environment. Studies confirm that affective design multimedia produces its strongest academic outcomes at the Grades 5–6 stage when warm colors, anthropomorphic elements, and engaging visual design are combined with rigorous instructional content and cognitive demands that are well-matched to learners' current proficiency levels, rather than when affective design features are used as substitutes for substantive instructional scaffolding (Lang et al., 2025; Christodoulou et al., 2024).

Common Limitations of the Studies

The findings reveal that one of the most salient challenges in existing research lies in the persistent methodological, contextual, and participant-related gaps that constrain the generalizability and applicability of multimedia effectiveness research. Across the reviewed studies, researchers explicitly acknowledge several recurring constraints that limit the field's capacity to generate generalized, causally robust knowledge needed to guide evidence-based instructional practice. This thematic domain is discussed across seven interrelated dimensions: (1) Restrictiveness; (2) Lack of Randomization; (3) Contextual and Subject Specificity; (4) Shallow Measurement Depth; (5) Selectivity; (6) Insufficient Intervention Detail; and (7) Limited Participant Diversity.

Restrictiveness. Small sample size is the most pervasive methodological limitation across the reviewed multimedia education studies, appearing consistently across different grade levels, geographic contexts, and multimedia formats, as evidenced by the following synthesized findings:

The study was limited by a small sample size that restricts the wider application of results to other schools, populations, or geographic regions (Ampuyos & Villaruz, 2022).

The small sample size limits generalizability; only 34 Grade 4 pupils were involved in a single school setting (Lagua, 2024).

The study acknowledged a small, non-diverse sample as a significant constraint on the wider applicability of its findings in science learning (Koto, 2020).

The sample was purposively selected from one intact class of 4th-grade students, limiting the generalizability of findings to other contexts or student populations (Febiyanti et al., 2021).

Only 48 children aged 5–6 from a relatively small sample participated, and the text does not specify the length of the intervention, limiting conclusions about long-term retention (Baltzaki & Chlapana, 2023).

The study was limited to 20 indigenous pupils in a single primary school, restricting the scope of conclusions to a narrow cultural and geographic context (Samat & Aziz, 2020).

Ampuyos and Villaruz (2022) acknowledged that their study was limited by a small sample size that restricts the wider application of results to other schools, populations, or geographic regions. Lagua (2024) similarly noted that only 34 Grade 4 pupils participated in a single school setting, constraining the extent to which findings can be extrapolated to other instructional contexts. Fokides and Arvaniti (2020) used a sample of only 44 students aged nine to ten, explicitly limiting the generalizability of 360-degree video findings, while Koto (2020) acknowledged a small, non-diverse sample as a significant constraint on the wider applicability of science learning conclusions. Febiyanti et al., (2021) purposively selected one intact class of fourth-grade students, and Baltzaki and Chlapana (2023) involved only 48 children aged five to six without specifying intervention length, further limiting conclusions about long-term vocabulary retention.

The restrictiveness of small sample sizes extends equally to studies with specialized or indigenous learner populations. Samat and Aziz (2020) restricted their study to 20 indigenous pupils in a single primary school, limiting conclusions to a narrow cultural and geographic context. Samosa et al. (2021) focused on only 30 Grade 3 students in a single school. While, Untong (2025) used merely 12 Grade 1 Teduray learners a sample so small that findings can only be considered indicative rather than definitive evidence of Cocomelon video effectiveness for indigenous language learners. Alyusfitri et al., (2024) used a one-shot case study involving only 24 Grade 5 students.

Small sample size and purposive sampling suggest results may be localized and may not reflect the national average for Grade 3 learners across different provinces. These patterns align with the broader literature, where sample of only 64 students in a pre-experimental design without a control group confirming that small sample size is a structural feature of multimedia education research that substantially limits the strength of both causal and generalizing conclusions across the field (Belgira et al., 2026; Torrington and Bower, 2021; Ahmada and Hilmiah, 2021).

The implication of these findings is that the widespread use of small and localized samples in multimedia education research significantly limits the reliability and generalizability of the reported outcomes. When studies involve only a small number of participants from a single class or school, the findings tend to reflect specific contextual conditions rather than broader educational realities. This implication indicates that although many studies report positive effects of multimedia integration, the limited scope of their samples weakens the strength of evidence needed to inform wider instructional practice and policy. Several studies corroborate this implication, noting that small or non-diverse samples restrict the applicability of findings across different educational settings and learner populations (Hall, 2024; Nuqui, 2021; Aryfien et al., 2025).

Future research should utilize larger and more diverse participant groups through multi-school or multi-regional studies to strengthen the validity and generalizability of multimedia learning findings. Expanding research contexts will provide stronger evidence for guiding effective multimedia integration in educational practice (Aligo & Prudente, 2025).

Lack of Randomization. Randomization and control groups is a pervasive design limitation that fundamentally undermines the causal validity of findings across multimedia education studies at all grade levels and formats, as the following synthesized findings demonstrate:

The one-group pre-test/post-test design and lack of randomization make it difficult to isolate video clips as the sole factor of improvement in student understanding (Lagua, 2024).

The study used a one-group design without randomization, limiting the ability to attribute learning gains exclusively to project-based learning videos (Febiyanti et al., 2021).

The pre- and post-test experimental design was conducted with a specific sample during a single academic semester without a fully randomized control, limiting causal claims (Koto, 2020).

The study employed a quasi-experimental design without full randomization, which may have limitations compared to a fully randomized controlled trial in establishing the causal effect of the SRP-VBLS (Hsu et al., 2022).

A one-shot case study design without randomization or control group comparison is a significant methodological constraint (Alyusfitri et al., 2024).

Lagua (2024) used a one-group pre-test/post-test design without randomization, making it impossible to isolate video clips as the sole causal factor responsible for improvement in Grade 4 weather science understanding. Febiyanti et al. (2021) employed a one-group design without randomization, limiting the ability to attribute listening comprehension gains exclusively to project-based learning video rather than to pandemic-related motivational dynamics or teacher effects. Irwam (2020) conducted a pre- and post-test study without a fully randomized control during a single academic semester, limiting causal claims about YouTube video-integrated discovery learning. Hsu et al. (2022) acknowledged a quasi-experimental design without full randomization, noting limitations in establishing causal effects of the Socratic Reflection Prompt video-based learning system compared to a fully randomized controlled trial.

Alyusfitri et al. (2024) used a one-shot case study entirely without randomization or control group, representing the most methodologically constrained design for causal claims about e-module effectiveness. Mohamed et al., (2025) acknowledged lack of full randomization and geographic specificity as limitations on internal validity of causal conclusions about differentiated multimedia instruction. Sosna et al. (2025) similarly noted that their quasi-experimental design without full randomization limits the ability to rule out confounding variables including teacher effects, novelty, and curriculum differences in evaluating 3D modeling's effect on creativity.

Other studies have found that quasi-experimental designs often fail to produce statistically significant differences in reading scores, while the absence of random assignment prevents researchers from ruling out pre-existing group differences as explanations for observed outcomes, and multiple evaluations utilizing small, purposively selected groups in pre-experimental designs have explicitly noted the lack of a control group as a primary constraint, confirming that these structural limitations are a widespread challenge across the research landscape (Starwati & Wachidah, 2023; Sandi, 2023).

The implication of these findings is that the lack of randomization and adequate control groups significantly weakens the causal validity of many multimedia education studies. When research relies on one-group, pre-experimental, or quasi-experimental designs without random assignment, it becomes difficult to determine whether observed learning gains are truly caused by multimedia tools or by other factors such as teacher influence, novelty effects, or existing learner differences. This implication indicates that many reported improvements associated with multimedia use should be interpreted cautiously because alternative explanations cannot be fully ruled out. Several studies corroborate this implication by acknowledging that the absence of

randomization and proper control conditions limits the ability to establish strong causal conclusions about multimedia effectiveness (Carroll, 2024; Samosa et al., 2021).

Future research should employ stronger experimental or quasi-experimental designs with random assignment or well-matched control groups to improve the causal validity of findings. Strengthening research design will enable more reliable conclusions about the true impact of multimedia tools on student learning outcomes (May et al., 2024; Torrington & Bower, 2021).

Contextual and Subject Specificity. Contextual and subject specificity represent a critical limitation on the transferability of multimedia education findings across different instructional contexts, subject areas, and national educational systems. The following synthesized findings highlight these limitations:

Findings are tied to a specific subject (English) and grade level (Grade 6) in a single school, limiting transferability to broader educational contexts (Ampuyos & Villaruz, 2022).

The study's focus solely on weather elements in a single school setting limits the applicability of findings to other science topics or grade levels (Lagua, 2024).

The study's exclusive focus on environmental education narrows the generalizability of 360° video findings to other subjects or age groups (Fokides & Arvaniti, 2020).

The study only tested multimedia animation using Ministry-approved story texts in Türkiye, restricting the findings to that specific text type and national curriculum context (Özdemir et al., 2025).

The study was limited to the development and validation of an interactive science module for Grade 6 learners containing specific least-learned competencies in one school (Mijares III, 2023).

The geographic and grade-specific focus on rural Grade 5 students limits the generalizability of CAP-S multimedia vocabulary findings to other grade levels and settings (McDonald et al., 2024).

The focus on a single grade level (Grade 5) and a single subject (Pakistan Studies) limits conclusions about whether multimedia effects are consistent across other subjects or grade levels (Ayub & Kiazai, 2021).

The scope of the study was narrowly focused on reading comprehension among indigenous pupils, excluding other literacy skills and subject areas (Samat & Aziz, 2020).

Ampuyos and Villaruz (2022) explicitly noted that findings are tied to a specific subject English and a single grade level in one school, limiting transferability to broader educational contexts. Lagua (2024) acknowledged that exclusive focus on weather elements in a single school setting limits the applicability of findings to other science topics or grade levels. Fokides and Arvaniti (2020) noted that exclusive focus on environmental education narrows the generalizability of 360-degree video findings to other subjects or age groups. Özdemir et al. (2025) noted that testing multimedia animation only using Ministry-approved story texts in Türkiye restricts findings to that specific text type and national curriculum context. Mijares III (2023) acknowledged limitation to an interactive science module for Grade 6 learners at a single school, preventing determination of whether quality validation would extend to other content areas or grade levels.

McDonald et al. (2024) noted that geographic and grade-specific focus on rural Grade 5 students limits the generalizability of CAP-S multimedia vocabulary findings to other settings and learner demographics. Ayub and Kiazai (2021) acknowledged that the narrow focus on Grade 5 Pakistan Studies limits conclusions about whether multimedia effects are consistent across other subjects or grade levels. Samat and Aziz (2020) noted that narrow focus on reading comprehension among indigenous pupils excludes other literacy skills and subject areas.

These patterns are corroborated by the broader literature, where Yonanda et al. (2024) acknowledged that study findings were tailored to a specific thematic unit and may not generalize to less visual subjects, and Baharuddin,

Nurhikmah, and Lu'mu (2024) noted that their study did not address whether multimedia design would be equally applicable across different age groups or subject areas. Studies noted that single-school and single-cohort constraints restricting Philippine-context multimedia generalizability, while highly dependent on the specific teacher's implementation approach confirming that teacher-level contextual specificity compounds subject and school-level limitations (Cruz et al., 2023; Arciaga, 2025; Najib et al., 2023).

The implication of these findings is that the strong contextual and subject specificity of many multimedia education studies limits the transferability of their results across different subjects, grade levels, and educational systems. When research is conducted within a single subject area, grade level, or school context, the findings may reflect conditions unique to that setting rather than universal instructional effects of multimedia tools. This implication indicates that although multimedia interventions may appear effective within a particular discipline or curriculum, their outcomes cannot automatically be generalized to other learning areas or educational environments. Several studies corroborate this implication by acknowledging that their findings were confined to specific subjects, grade levels, or institutional contexts, thereby restricting broader applicability (Yonanda et al., 2024; Baharuddin et al., 2024).

Future studies should examine multimedia interventions across multiple subjects, grade levels, and educational settings to strengthen the transferability of findings. Conducting cross-disciplinary and multi-context research can generate more comprehensive evidence on how multimedia supports learning across diverse instructional environments (Polat et al., 2025; Hamidi et al., 2024).

Shallow Measurement Depth. The study relies on self-report scales, meaning findings reflect participants' perceptions rather than direct measures of mathematical performance attributable to multimedia. This limitation is underscored by the following synthesized findings:

The study relies primarily on self-reported data, which may not fully capture objective learning outcomes beyond student perceptions of 360° video effectiveness (Fokides & Arvaniti, 2020).

Data collection relied solely on pre- and post-tests, potentially limiting the depth of understanding of student learning across factual, conceptual, and procedural dimensions (Koto, 2020).

Longitudinal retention effects beyond the immediate post-test were not measured, leaving open questions about the durability of multimedia-enhanced vocabulary learning over time (Thangprasert et al., 2025).

The study captures only a snapshot in time through a cross-sectional design, rather than tracking literacy development across multiple years (Wan Norudin et al., 2024).

Experiment 2 revealed a 'performance plateau' where improved emotional states did not immediately translate into higher test scores, suggesting emotional design multimedia may affect engagement more directly than complex cognitive processing (Lang et al., 2025). The short duration of the community service program limited conclusions about the sustained effectiveness of picture story books for literacy development outside the classroom (Nurmaelinda & Jesicha, 2025).

Shallow measurement depth primarily manifested through reliance on single-timepoint pre/post tests, self-report instruments, and the absence of longitudinal follow-up is a pervasive limitation that systematically undermines the comprehensiveness and durability of multimedia effectiveness conclusions across the reviewed literature. Fokides and Arvaniti (2020) noted that primary reliance on self-reported data may not fully capture objective learning outcomes beyond student perceptions of 360-degree video effectiveness. Koto (2020) acknowledged that data collection relying solely on pre- and post-tests potentially limits the depth of understanding of student learning across factual, conceptual, and procedural dimensions and explicitly noted that the long-term impact of YouTube video-combined discovery learning was not assessed because the intervention lasted only four weeks.

Thangprasert et al. (2025) documented that longitudinal retention effects beyond the immediate post-test were not measured, despite finding that long-term retention had already declined relative to short-term retention at the

seven-day follow-up raising serious concerns about vocabulary learning durability. Wan Norudin et al. (2024) acknowledged that their cross-sectional design captures only a snapshot in time rather than tracking literacy development across multiple years.

The shallow measurement depth limitation extends to instrument quality and intervention duration across additional studies. Christodoulou et al. (2024) relied on self-report scales, meaning findings reflect participants' perceptions rather than direct measures of mathematical performance attributable to multimedia use. Lang et al., (2025) identified a performance plateau in Experiment 2 where improved emotional states did not immediately translate into higher test scores a finding that would have been completely missed by conventional pre/post measurement frameworks that do not include within-intervention assessment checkpoints.

Nurmaelinda and Jesicha (2025) acknowledged that the short duration of their community service program limited conclusions about sustained picture story book effectiveness for literacy development outside the classroom. These patterns are corroborated throughout the broader literature, where Santos (2025) found a 30-day intervention too short for measurable deep-seated reading change. Shim (2023) noted the short duration of VR sessions as a limitation. Self-reported data across multiple studies was flagged for potential response bias (Sartono, Prasetia, & Senen, 2024; Tarishah & Yatri, 2025; Waluyo & Apridayani, 2021). Hsieh (2020) acknowledged a narrow focus on isolated vocabulary rather than holistic language learning, while Pattemore and Muñoz (2020) noted substantial exposure time requirements and limited instructional time constraints both of which restrict the assessment breadth and duration that researchers can practically achieve in real school contexts.

The implication of these findings is that the shallow measurement approaches used in many multimedia education studies limit the accuracy and depth of conclusions about multimedia's true impact on learning. When studies rely heavily on self-report instruments, short-term pre- and post-tests, or single-timepoint data collection, the results often reflect learners' perceptions or short-term performance rather than sustained cognitive development. This implication suggests that many reported multimedia learning gains may overestimate actual educational impact because long-term retention, transfer of learning, and deeper conceptual understanding are rarely measured. Several studies corroborate this implication, noting that reliance on perception-based measures, short interventions, and the absence of longitudinal follow-up restrict the ability to evaluate durable learning outcomes (Fokides & Arvaniti, 2020; Koto, 2020; Wan Norudin et al., 2024; Lang et al., 2025; Thangprasert et al., 2025; Nurmaelinda & Jesicha, 2025).

Future research should employ deeper measurement frameworks that include longitudinal follow-up, validated performance assessments, and mixed-method data collection. Using multi-timepoint evaluations can provide stronger evidence on the durability and real educational impact of multimedia learning interventions (Hall, 2024; Furenes et al., 2021; Polat et al., 2025).

Selectivity. In multimedia education research refers to the tendency of studies to report only on interventions that show positive outcomes, while studies with null or negative findings are rarely published or foregrounded. The reviewed literature reveals a discernible pattern in which multimedia tools are consistently reported as effective while studies yielding insignificant or contradictory results receive comparatively limited attention, creating an optimistic but potentially skewed picture of multimedia effectiveness across elementary educational contexts. This dimension of selectivity is substantiated by the following synthesized findings:

No significant improvement in academic performance was found through video instruction despite increased behavioral engagement, a finding that stands in sharp contrast to the overwhelmingly positive outcomes documented elsewhere in the literature (Torrington & Bower, 2021).

No statistically significant difference in reading scores for Lexia Core5 users was found, a result attributed partly to quasi-experimental design limitations but that also raises the possibility that the tool's effectiveness was more limited than promotional literature suggested (Carroll, 2024).

The experimental group's gains from Microsoft Immersive Reader did not reach statistical significance, a null finding that was reported but received substantially less discussion than its positive counterparts in comparable studies (Santos, 2025).

A lack of direct correlation between high motivation and actual academic performance was acknowledged, a dissociation that raises fundamental questions about whether motivational benefits from multimedia tools reliably translate into measurable cognitive gains (Hall, 2024).

Polat, Taş and Yıldırım (2025) observed that multimedia learning research remains dominated by cognitive outcome metrics and Western scholarly frameworks, with insufficient attention to null findings, sociocultural outcomes, and non-Western perspectives a structural selectivity that extends beyond individual studies to shape the entire evidence base. Furenes, Kucirkova, and Bus (2021) noted in their meta-analysis that rough distinctions between types of digital enhancements limited nuanced conclusions, precisely because primary studies selectively reported aggregate effects without disaggregating tool-specific or context-specific null outcomes. Aryfien, Atmojo, and Matsuri (2025) found that their systematic review was constrained by international database focus and could not fully represent locally published research a form of selectivity that renders the evidence base disproportionately reflective of published, typically positive, findings from internationally indexed journals rather than from the full range of multimedia effectiveness research conducted in Philippine and Asian contexts. Lang et al. (2025) provided a particularly telling illustration: while emotional design elements improved student mood and engagement, a performance plateau emerged in which emotional gains did not translate into academic results a nuanced finding that would likely be omitted from studies selectively reporting only significant positive outcomes.

The implication of these findings is that selectivity in multimedia education research may create an overly optimistic representation of multimedia effectiveness. When studies with positive outcomes are more frequently reported while null or insignificant results receive limited attention, the evidence base becomes skewed, making multimedia tools appear more consistently effective than they may actually be in diverse educational contexts. This implication suggests that educators and policymakers should interpret reported multimedia benefits cautiously because the published literature may not fully represent mixed or negative outcomes. Several studies corroborate this implication by documenting cases where multimedia interventions produced limited or non-significant academic improvements despite positive engagement or motivational effects (Torrington & Bower, 2021; Carroll, 2024; Santos, 2025; Hall, 2024; Lang et al., 2025; Polat et al., 2025; Furenes et al., 2021).

Future research should promote transparent reporting of both positive and null findings and expand systematic reviews to include diverse and locally published studies. Doing so can provide a more balanced evidence base for evaluating multimedia effectiveness and guiding responsible educational policy and practice (Aryfien et al., 2025; Torrington & Bower, 2021; Carroll, 2024).

Limited Participant Diversity. Limited participant diversity refers to the narrow demographic and cultural range of learners included in existing multimedia education studies, which restricts the applicability of findings to broader and more varied student populations. Across the reviewed literature, study samples were predominantly drawn from single-school, single-grade-level, single-subject, and often majority non-indigenous contexts, leaving significant gaps in the evidence base regarding how multimedia affects learners from diverse cultural, socioeconomic, linguistic, and developmental backgrounds. This dimension is substantiated by the following synthesized findings:

Restricted their study to 20 indigenous pupils in a single primary school, limiting conclusions to a narrow cultural and geographic context that cannot be generalized to non-indigenous learner populations or to indigenous communities with different linguistic and cultural backgrounds (Samat and Aziz, 2020).

used merely 12 Grade 1 Teduray learners a sample so small and culturally specific that findings can only be considered indicative rather than definitive evidence of Cocomelon video effectiveness for indigenous language learners (Untong, 2025).

Involved only 48 children aged five to six from a relatively homogeneous sample without specifying intervention length, limiting conclusions about vocabulary retention across diverse early childhood demographics (Baltzaki & Chlapana, 2023).

One-shot case study involving only 24 Grade 5 students from a single school, excluding the gender, socioeconomic, and linguistic diversity needed to assess whether e-module effects generalize across different learner characteristics (Alyusfitri et al., 2024).

Small sample size and purposive sampling from one location suggest results may not reflect the national average for Grade 3 learners across different provinces and demographic contexts (Belgira et al., 2026).

Thangprasert, Owatnupat, and Jitsupa (2025) explicitly noted the need for broader participant diversity and longer-duration studies to confirm retention effects across different learner populations. Polat, Taş and Yıldırım (2025) similarly observed that the field remains shaped predominantly by Western scholarly frameworks, with insufficient attention to non-Western learner perspectives a structural gap that directly limits the diversity of participant populations represented in the global multimedia evidence base. Dong et al., (2024) found that a literacy intervention was less effective when delivered remotely due to connectivity and infrastructure constraints, revealing that participant diversity extends beyond demographic characteristics to encompass infrastructural and access-related differences that profoundly shape multimedia's educational impact. McDonald et al. (2024) noted that geographic and grade-specific focus on rural Grade 5 students limits the generalizability of multimedia vocabulary findings to other settings and learner demographics, confirming that even studies designed to serve underrepresented populations often do so with samples too narrow to generate transferable conclusions. Pujiariani and Cathrin (2025) further noted that multimedia tool success was heavily dependent on hardware availability in remote schools a finding that highlights how participant diversity in technology access shapes outcome variability in ways that homogeneous, single-school samples cannot adequately capture.

The implication of these findings is that the limited diversity of participants in multimedia education studies restricts the generalizability of research conclusions to broader learner populations. Because many studies rely on small samples from single schools, grade levels, or culturally homogeneous groups, the results may not accurately represent how multimedia interventions affect learners with different cultural, linguistic, socioeconomic, and technological backgrounds. This implication suggests that multimedia effectiveness reported in the literature may apply only to the specific contexts in which the studies were conducted rather than to the wider and more diverse populations of elementary learners. This implication is corroborated by several studies that reported narrow or culturally specific samples, which limit the transferability of findings across different learner groups and educational contexts (Samat & Aziz, 2020; Untong, 2025; Alyusfitri et al., 2024; McDonald et al., 2024; Thangprasert et al., 2025; Polat et al., 2025).

Future studies should include more diverse and representative participant groups across different cultural, socioeconomic, and geographic contexts. Expanding sample diversity and incorporating inclusive research frameworks can strengthen the validity and applicability of multimedia education findings for a wider range of learners (Dong et al., 2024; Pujiariani & Cathrin, 2025).

Development of an Evidence-Based Teaching Primer

The final output of this study is the development of an evidence-based teaching primer on the effective use of multimedia in elementary education. This primer was developed based on the findings of the meta-analysis, which identified the effects of multimedia, appropriate tools for different developmental stages, and the common limitations in existing studies.

The teaching primer serves as a practical guide for teachers in selecting and using multimedia tools effectively. The findings of this study showed that multimedia tools should be aligned with learners' developmental stages. This is supported by the literature. For example, Sibulo (2025) and Miranda (2025) found that audiovisual and visual multimedia materials are effective for early learners because they support basic literacy skills. Similarly,

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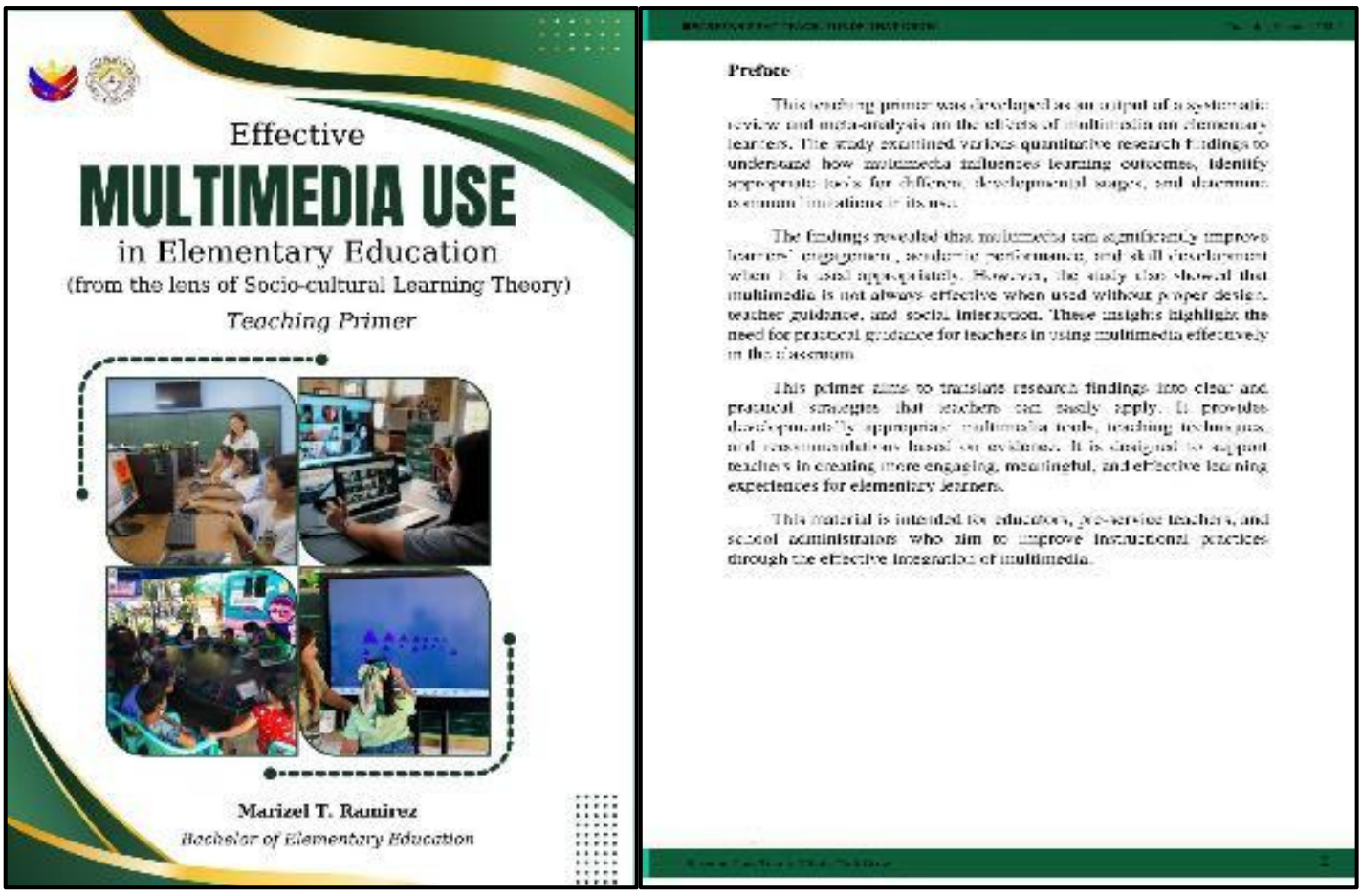
Alyusfitri et al. (2024) and Yonanda et al. (2024) reported that interactive multimedia and e-modules are more effective for older learners as they support higher-order thinking and independent learning. These studies confirm that selecting appropriate multimedia tools based on learners' level is essential for effective instruction.

Another important component of the teaching primer is the role of teacher guidance and interaction. The findings of this study showed that multimedia is more effective when combined with active teaching strategies. This is supported by May, Strong, and Walpole (2024), who found that teacher training improves the effective use of multimedia in the classroom. Similarly, Waluyo and Apridayani (2021) emphasized that lack of teacher training limits the actual use of multimedia despite positive attitudes. These studies show that teacher involvement is necessary to maximize the benefits of multimedia.

The teaching primer also addresses the limitations identified in previous studies, particularly issues related to access and implementation. Studies such as Pujiariani and Cathrin (2025) and Belgira et al. (2026) highlighted that limited access to technology and unequal distribution of resources affect the effectiveness of multimedia in education. These findings support the inclusion of practical strategies in the primer to help teachers adapt multimedia tools to different classroom contexts.

From a theoretical perspective, the development of the teaching primer is supported by both Sociocultural Theory of Learning (SCT) and the Cognitive Theory of Multimedia Learning (CTML). SCT explains that multimedia functions as a cultural tool that supports learning through interaction, scaffolding, and guided participation. This supports the inclusion of collaborative and teacher-guided activities in the primer. On the other hand, CTML explains how learners process multimedia information and highlights the importance of proper design to avoid cognitive overload. This supports the inclusion of design principles in the primer.



Acknowledgment

The researcher would like to express sincere gratitude to all individuals who contributed to the completion of this study and the development of this teaching primer.

First and foremost, heartfelt thanks are extended to the Almighty God for the guidance, strength, and wisdom throughout the entire research process.

The researcher also expresses deep appreciation to her adviser for the continuous support, valuable suggestions, and guidance that greatly improved the quality of this work. Special thanks are given to the panel members for their insightful comments and recommendations which helped refine the study.

Gratitude is also extended to the authors and researchers whose published works served as the foundation of this systematic review and meta-analysis. Their contributions made this study possible.

The researcher is deeply thankful to her family for their unwavering support, encouragement, and understanding throughout this journey.

Finally, appreciation is given to all who in one way or another, contributed to the completion of this study.

— Marilyn J. Ramirez

Objectives

This teaching primer aims to provide practical and evidence-based guidance for teachers on the effective use of multimedia in elementary education. Specifically, it seeks to:

1. Present the key findings of the systematic review and meta-analysis on the effects of multimedia on learners in a simplified and applicable format.
2. Identify multimedia tools that are appropriate for different developmental stages of elementary learners.
3. Provide clear teaching strategies that promote effective, interactive, and developmentally appropriate use of multimedia in the classroom.
4. Highlight common misconceptions and challenges in using multimedia and suggest practical solutions for teachers.
5. Support teachers in designing learning experiences that integrate multimedia with sociocultural principles such as interaction, scaffolding, and guided learning.
6. Serve as a practical guide for improving learner engagement, motivation, and academic performance through effective multimedia integration.

Table of Contents

1 Multimedia

The combination of two or more media forms that unites video, images, animation, and interactivity integrated into a single educational tool or instructional experience designed to enhance learning.

Multimedia is not merely "technology in the classroom." It is a mediational tool a bridge between where learners currently are and where the curriculum needs them to go. When thoughtfully designed and aligned with learners' developmental needs, multimedia becomes one of the most powerful instruments in an educator's repertoire.

Theoretical Foundations

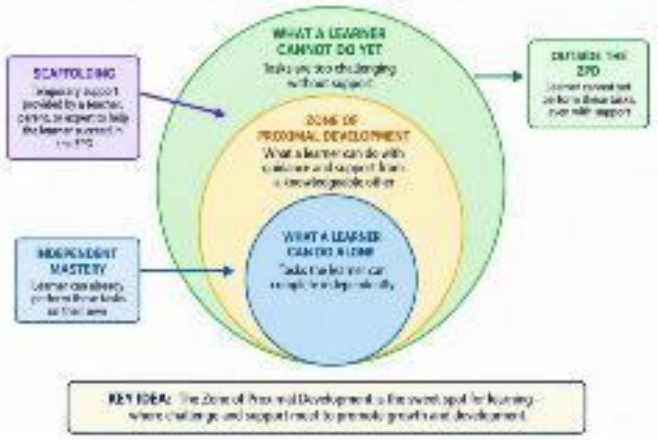
The effectiveness of multimedia in education does not happen by accident. It is explained by well-established learning theories that form the scientific foundation of this primer.

Sociocultural Learning Theory (Vygotsky, 1978)

Lev Vygotsky argued that all higher cognitive functions appear first between people and are then internalized as individual mental capacities. According to Vygotsky, learners understand new knowledge most effectively within the Zone of Proximal Development (ZPD), which is the gap between what they can do independently and what they can accomplish with guidance. In this zone, teachers, parents, or more capable peers provide scaffolding through explanation, modeling, questioning, and guided practice until learners become independent. This theory is critical to multimedia education because it explains why technology alone is insufficient. multimedia produces its strongest outcomes when it functions as a shared mediational tool within a human learning relationship, not as an isolated digital activity. Videos are most powerful when discussed. Simulations are most effective when paired with teacher guidance. Vocabulary tools lead to far more than social interaction (Vygotsky, 1978; Wood et al., 1976; Moore, 2024).

Zone of Proximal Development

The concept of the Zone of Proximal Development (ZPD), introduced by Lev Vygotsky, provides a foundational framework for understanding how learning and cognitive development occur through social interaction and guided support. The ZPD represents the range between what a learner can accomplish independently and what they can achieve with the assistance of a more knowledgeable other, such as a teacher, parent, or peer. This theoretical perspective emphasizes that learning is not a solitary process but is deeply embedded in social contexts where guidance plays a crucial role in advancing a learner's capabilities. The following points outline the key components of the ZPD and their implications for effective teaching and learning.



1. **Independent Level (What the learner can do alone)**
   - Represents mastered skills and knowledge
   - Tasks can be completed without assistance
   - Indicates the learner's current developmental level
2. **Zone of Proximal Development (Learning Zone)**
   - Includes tasks the learner cannot yet do independently
   - Achievable with guidance from a more knowledgeable other
   - Considered the most effective area for teaching and learning
3. **Learning Potential and Development**
   - Bridges the gap between current ability and future capability
   - Promotes gradual internalization of knowledge and skills
   - Enhances both competence and confidence
4. **Scaffolding (Support Mechanism)**
   - Temporary assistance provided by teachers, parents, or peers
   - Includes strategies such as modeling, questioning, and feedback
   - Helps learners successfully perform tasks within the ZPD
5. **Gradual Release of Responsibility**
   - Support is reduced as the learner becomes more competent
   - Encourages independence and self-regulation
   - Leads to mastery of previously challenging tasks
6. **Tasks Beyond the ZPD (Too Difficult)**
   - Cannot be accomplished even with support
   - May cause frustration or disengagement
   - Should be avoided until the learner is developmentally ready

Balance of Challenge and Support
- Learning is maximized when tasks are moderately challenging
- Too easy → no growth; too difficult → no learning
- ZPD represents the optimal balance point

Instructional Implications
- Teachers must assess learners' current abilities
- Design tasks within the ZPD

- Apply appropriate scaffolding strategies

Effective Teaching Strategies
- Guided practice
- Differentiated instruction
- Collaborative learning
- Continuous formative assessment

Scaffolding

The concept of scaffolding is grounded in the learning theory of Lev Vygotsky, particularly his idea of the Zone of Proximal Development (ZPD). This theory emphasizes that learning is most effective when instruction targets the space between what learners can do independently and what they can achieve with guidance. Scaffolding therefore, serves as a structured support system that enables learners to gradually build competence and confidence in performing new tasks. Through guided assistance, timely feedback, and strategic use of instructional tools, learners are supported until they can function independently. The process is dynamic and responsive, ensuring that support is adjusted based on the learner's needs and progress. The following steps outline how scaffolding is systematically applied to facilitate meaningful learning within the ZPD.

Steps of Scaffolding

1. **Identify Learner's Current Level**
   - This step focuses on assessing what the learner can already do independently.
   - It establishes the learner's baseline knowledge and skills without assistance.
   - Teachers use observations, prior assessments, or diagnostic tasks to determine readiness.
   - This ensures that instruction begins at an appropriate level—not too easy or too difficult.
2. **Determine the Zone of Proximal Development (ZPD)**
   - The ZPD represents tasks the learner cannot yet do alone but can accomplish with guidance.
   - It is the "sweet spot" for learning—challenging but achievable.
   - Identifying this zone allows teachers to target instruction effectively.
   - This step bridges the gap between current ability and potential development.
3. **Provide Scaffolding Support**
   - Teachers introduce structured support to help learners succeed within their ZPD.

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- Examples include:
  - Teacher guidance (modeling, explaining, questioning)
  - Multimedia tools (videos, interactive content)
  - Peer collaboration (group work, peer tutoring)
- Support is intentional and temporary, designed to build competence.

4. **Guided Practice**
   - Learners actively engage in tasks with assistance, prompts, and feedback.
   - The teacher gradually shifts from direct instruction to facilitation.
   - Mistakes are used as learning opportunities.
   - This stage strengthens understanding through practice within support.
5. **Gradual Release of Responsibility**
   - Support is slowly reduced as the learner becomes more competent.
   - The teacher transitions from "I do" → "We do" → "You do."
   - Learners begin taking more ownership of the task.
   - This step ensures independence is developed progressively, not abruptly.
6. **Independent Performance**
   - The learner can now complete the task successfully without assistance.
   - Demonstrates mastery of the skill or concept.
   - Confirms that learning has moved beyond the ZPD into actual development.
   - Encourages confidence and self-efficacy.
7. **Internalization of Learning**
   - Knowledge becomes part of the learner's own thinking and understanding.
   - Skills are retained, transferable, and can be applied in new contexts.
   - Learning is no longer dependent on external support.
   - This marks the full realization of cognitive development as described in ZPD theory.

2 Why Use Multimedia?

Improves Understanding

Multimedia uses pictures, videos, and sounds to explain ideas clearly. This helps students understand lessons faster and remember them better (Mayer, 2024; Cruz et al., 2023; Nugu, 2021).

Develops Thinking and Literacy Skills

Using multimedia helps students think more deeply and improves their reading, writing, and communication skills (Hsu et al., 2022; Alyusfin et al., 2024; Febiyanti et al., 2021; Samson et al., 2021).

Increases Engagement

Multimedia makes lessons more interesting and enjoyable, which keeps students focused and motivated to learn (Almazer & Labitad, 2024; Hall, 2024; Panaga Lim & Tomala Chavez, 2023).

Note for Teacher

Always guide students when using multimedia to make sure learning stays meaningful and purposeful.

Effects of Multimedia

Research shows multimedia can be powerful but only when used wisely. Knowing both the good and the challenging effects will help you use multimedia in ways that truly benefit every learner (Mayer, 2024; Aligo & Prudente, 2025; Torrington & Bower, 2021).

Effects of multimedia on learners

What Works

- Video Improves Learning Outcomes	Using videos in teaching helps students understand lessons better and get higher scores (Ampuyas & Villanux, 2022; Cruz et al., 2023; Nucut, 2021; Hall, 2024).
- Video Mediates Early Childhood Skill Development	Videos help young children learn basic skills like reading, speaking, and even moving their bodies (Mohammad & Benchérry, 2023; Sibulo, 2025; Unlong, 2025; Hennar et al., 2025).
- Multimedia Supports Higher-Order Thinking	Using videos, animations, and interactive tools helps students think deeper, such as analyzing and solving problems (Hsu et al., 2022; Alyusfin et al., 2024; Yani, 2025; Pratiwi & Rezania, 2021).
- Multimedia Improves Literacy and Writing Skills	Multimedia like videos and digital stories helps students improve reading, listening, and writing (Febiyanti et al., 2021; Samson et al., 2021; Ahmada & Hilmiah, 2021; Tran Thien, 2022).
- Social Mediation Enhances Multimedia Effectiveness	Multimedia works better when students learn with others, like teachers, classmates, or parents (Baltzaki & Chlapana, 2023; Waluyo & Apridayani, 2021; Aligo & Prudente, 2025).
- Culturally Relevant Multimedia Improves Learner Engagement	Students learn better when multimedia content reflects their culture, language, and real life experiences (Zhang, 2024; Unlong, 2025; Yancam & Agustika, 2022; Samson et al., 2024).
- Multimedia Improves Vocabulary and Language Performance	Using multimedia like videos, pictures, audio and text helps students learn new words and improves how they understand and use language (McDonald et al., 2024; Thangprasert et al., 2025; Hsieh, 2020; Baltzaki & Chlapana, 2023).

What Does Not Work

- Multimedia Does Not Outperform Traditional Methods	Using multimedia does not always lead to better learning than traditional teaching like books or hands-on activities (Torrington & Bower, 2021; Bakalis & Arvaniti, 2020; Almazer & Labitad, 2024).
- Single Modality Multimedia Reduces Comprehension	Using only one type of media (like audio only or visuals only) can make learning harder to understand (Özdemir et al., 2025; Samat & Aziz, 2020; Thangprasert et al., 2025).

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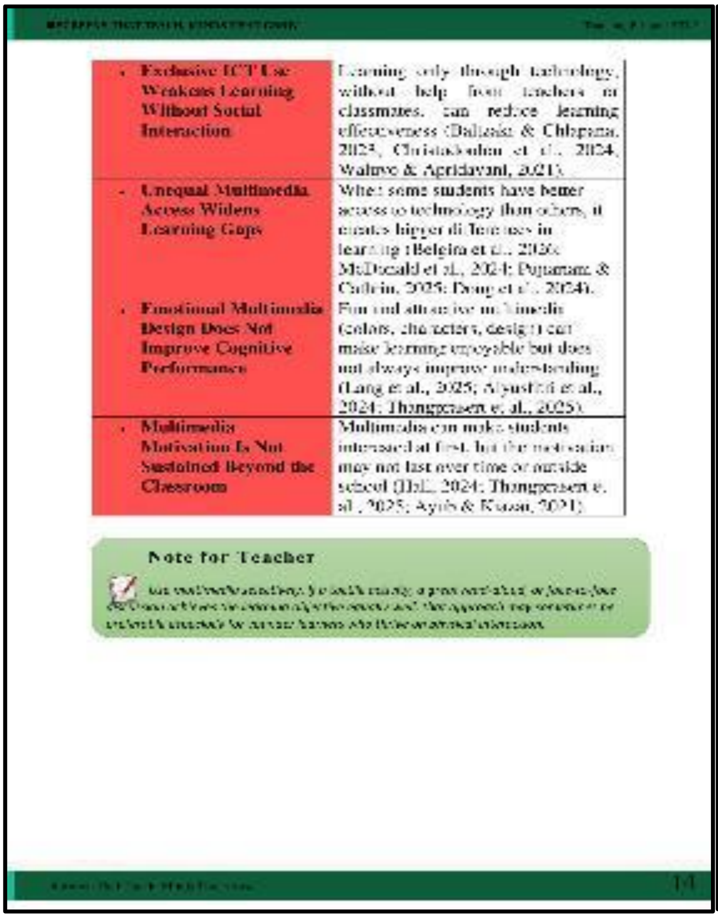

• Exclusive ICT Use Weakens Learning Without Social Interaction	Learning only through technology, without help from teachers or classmates, can reduce learning effectiveness (Daltzaki & Chlapana, 2023; Christakoudan et al., 2024; Waluyo & Apridayani, 2021).
• Unequal Multimedia Access Widens Learning Gaps	When some students have better access to technology than others, it creates bigger differences in learning (Belgira et al., 2026; McDonald et al., 2024; Pujiarti & Cathrin, 2025; Deng et al., 2024).
• Emotional Multimedia Design Does Not Improve Cognitive Performance	Fun and attractive multimedia (colors, characters, design) can make learning enjoyable but does not always improve understanding (Lang et al., 2025; Alyusfitri et al., 2024; Thongpraserr et al., 2025).
• Multimedia Motivation Is Not Sustained Beyond the Classroom	Multimedia can make students interested at first, but the motivation may not last over time or outside school (Hall, 2024; Thongpraserr et al., 2025; Ayob & Kasan, 2021).

Note for Teacher

[illegible]

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3 Recommended Multimedia Tools by Developmental Stage

Each stage has different needs, strengths, and ideal multimedia tools. As children grow, the social contexts of learning change and our multimedia choices must grow with them (Sibulo, 2025; Miranda, 2025; Alyusfitri et al., 2024; Yamada et al., 2024).

Developmental Stages of Learning

Four developmental learning stages from Kindergarten to Grade 6

A Kindergarten (Ages 4–6)
Imitative Play-Based Learning Stage

At the earliest stage of formal schooling, children learn primarily by watching, imitating, and repeating. The brain is absorbing patterns of movement, of sound, of language through rich sensory experience embedded in social play. Multimedia at this stage must be visually clear, repetitive, culturally familiar, and socially embedded (Mohammad & Boushehry, 2023; Sibulo, 2025; Daltzaki & Chlapana, 2023; Zhang, 2024).

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Challenges and Strategies

Challenge	Short attention spans cause learners to disengage from longer videos.
Strategy	Use clips no longer than 3–5 minutes. Pause frequently and ask "What did you see?" Build in movement breaks between media segments.
Challenge	Passive screen watching replaces active play.
Strategy	Always pair video viewing with a physical response: clapping, repeating words, acting out characters. Never use video as a babysitter.
Challenge	Technology access is uneven in early childhood settings.
Strategy	Default to traditional tools (realia, picture books) whenever devices are unavailable. Technology supplements; it does not replace hands-on materials.

Best Multimedia Formats

Movement Instruction Videos; Digital Vocabulary Games (tablets)

Topics with Appropriate Multimedia Tools (Kindergarten)

Learning Area	Competency	Suggested Multimedia Tool
FILIPINO	Napapakinggan at nauulit ang mga simpleng salita at tunog.	Animated Filipino songs (e.g., 'Bahay Kubo' animated); Cocomelon-style Filipino videos.
MATHEMATICS	Identifies numbers 1–10 and matches to quantity.	Counting songs with visual number animations; Smart Box digital game.
PHYSICAL EDUCATION	Performs basic locomotor movements.	Movement instruction videos (YouTube PE for kids); blended video guided activity.

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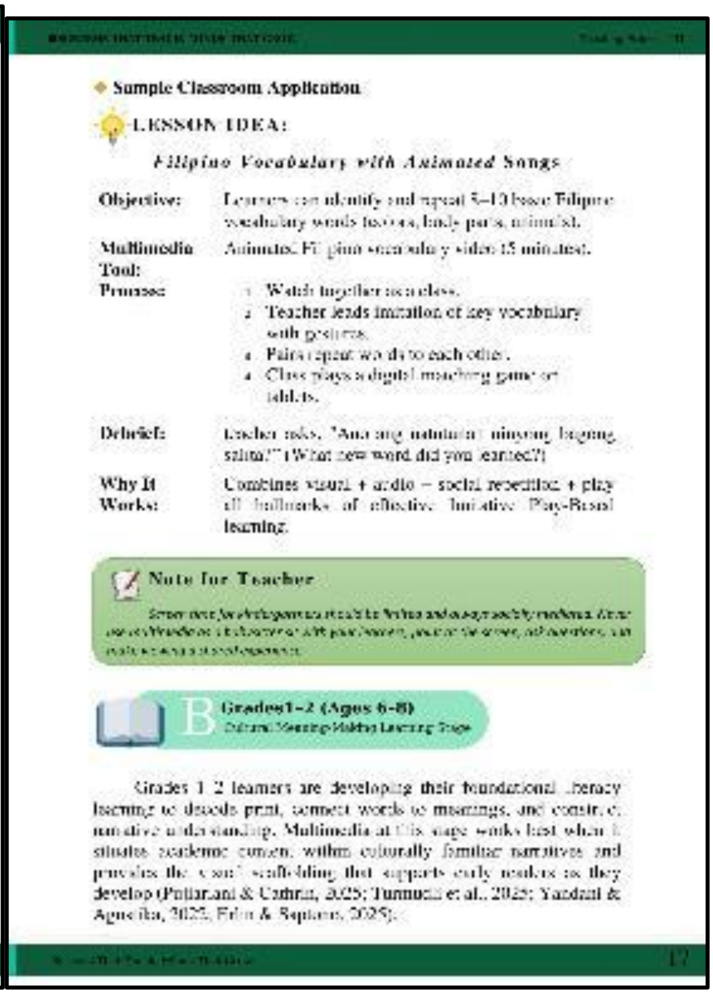

Sample Classroom Application

LESSON IDEA:

Filipino Vocabulary with Animated Songs

Objective:	Learners can identify and repeat 5–10 basic Filipino vocabulary words (colors, body parts, animals).
Multimedia Tool:	Animated Filipino vocabulary video (5 minutes).
Process:	1. Watch together as a class. 2. Teacher leads imitation of key vocabulary with gestures. 3. Pairs repeat words to each other. 4. Class plays a digital matching game on tablets.
Debrief:	Teacher asks, "Ano ang natutunan ninyong bagong salita?" (What new word did you learn?)
Why It Works:	Combines visual + audio + social repetition + play, all hallmarks of effective Imitative Play-Based learning.

Note for Teacher

[illegible]

B Grades 1–2 (Ages 6–8)
Cultural Meaning-Making Learning Stage

Grades 1–2 learners are developing their foundational literacy, learning to decode print, connect words to meanings, and construct narrative understanding. Multimedia at this stage works best when it situates academic content within culturally familiar narratives and provides the social scaffolding that supports early readers as they develop (Pulliani & Cathrin, 2025; Tunnucci et al., 2025; Yazdani & Agustika, 2025; Erlin & Septiana, 2025).

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Challenges and Strategies

Challenge Foreign-culture videos fail to engage culturally diverse learners.

Strategy Curate culturally situated content: Filipino folk tales, local community stories, ethnomathematics videos. When content is unavailable, use traditional books as primary and video as supplement.

Challenge Learners who cannot yet read independently fall behind during text-heavy media.

Strategy Use audio and read-aloud where audio and highlighted text appear simultaneously. Pair weaker readers with stronger readers during intensive storybook activities.

Challenge Transition from video to writing tasks is difficult for emergent writers.

Strategy Use printed story cards for sequencing before writing. Provide sentence frames. Allow oral retelling before written response. Screen time at home is often passive entertainment; learners arrive with low media literacy.

Best Multimedia Formats

- Narrative Picture Story Books (digital/print)
- Phonics Songs & Videos
- Culturally Situated Educational Videos
- Ethnomathematics Videos
- Interactive Read Aloud Apps

Topics with Appropriate Multimedia Tools (Grades 1-2)

Learning Area	Competency	Suggested Multimedia Tool
ENGLISH	Identify story elements (character, setting, plot).	Animated picture book read-aloud video, digital storybook with audio narration.
MATHEMATICS	Perform basic addition and subtraction (sums up to 20) using concrete and pictorial representations.	Ethnomathematics video featuring local market/community context for addition scenarios.
ARALING PANLIPUNAN	Identify and describe community helpers and their roles in the local community.	Culturally situated video featuring Filipino community helpers; picture story book about barangay life.

Sample Classroom Application

LESSON IDEA:

Story Elements Through Animated Picture Book (English Reading Comprehension, Grade 2).

Objective: Learners can identify character, setting, and problem-solution in a short story.

Multimedia Tool: Animated Filipino picture story (available on DepEd Learning Portal or YouTube).

Process:

1. Teacher introduces story vocabulary (character, setting, problem, solution) with illustrated flashcards.
2. Class watches the animated story together.
3. Teacher pauses at key moments and asks: "Sino ang karakter? Saan nangyayari? Ano ang problema?"
4. Learners draw their favorite scene.
5. Pairs share their drawings.

Why It Works: Visual narrative scaffolding + teacher-led social mediation + creative response — the perfect Grade 1–2 multimedia sequence.

Grades3-4 (Ages 8-10)

Grades 3–4 mark a critical transition in literacy learners shift from learning to read to reading to learn. [illegible] at this stage must support abstract concept formation, scaffold increasingly complex text comprehension, and begin to develop reflective and analytical thinking. Multiple simultaneous modalities [illegible] and text together produce the strongest outcomes here ([illegible] et al., 2023; [illegible] et al., 2024; [illegible] et al., 2025; [illegible] & [illegible], 2026).

Challenges and Strategies

Challenge Learners watch videos passively and cannot recall key concepts afterward.

Strategy Use a 'pause and predict' technique every 2–3 minutes. Provide a graphic organizer with 3 questions to fill in while watching.

Challenge Make thinking visible before, during, and after viewing.

Strategy Collaborative digital tasks (Google Slides, Canva) produce unequal participation.

Assign specific roles: Researcher, Designer, Presenter, Fact Checker. Rotate roles across tasks. Grade group process as well as product.

Challenge 360° or immersive videos cause novelty-driven distraction rather than learning.

Strategy Preview the immersive environment before the learning task. Provide a structured observation checklist.

Debrief immediately with guided questions.

Best Multimedia Formats

- Subject Specific Instructional Video Clips
- Animated Story Videos

- Interactive Reflection Video Modules
- Multi-Element Digital Media
- Collaborative Project-Based Videos
- Immersive 360° Video
- Comic Media & Cartoon Instruction

Topics with Appropriate Multimedia Tools (Grades 3-4)

Learning Area	Competency	Suggested Multimedia Tool
SCIENCE	Describe weather patterns and their effects on communities.	Subject specific instructional video about weather elements; animated weather explainer.
ENGLISH	Write narrative and descriptive paragraphs with correct grammar and story structure (Grades 3).	Animated story video as pre-writing scaffold; story based animated video for writing structure.
MATHEMATICS	Solve word problems involving multiplication and division using multi-step strategies (Grade 3-4).	Multi-element digital media with visual, audio, and text walkthroughs of problem-solving steps.
ARALING PANLIPUNAN	Explain the contributions of pre-colonial Filipino civilizations; evaluate the impact of Spanish colonization.	Collaborative project video — interactive history digital media with visual maps and timelines.

Sample Classroom Application

LESSON IDEA:

Writing A Narrative Paragraph Using Animated Story Video (English Writing, Grade 3)

Objective: Learners will write a 5-sentence narrative paragraph with a clear beginning, middle, and end.

Multimedia Tool: Animated story video (6–8 minutes) featuring a relatable protagonist.

Process:
1. Watch animated story.
2. Discuss: "What happened at the beginning? Middle? End?"
3. Teacher models a simple story outline on the board using the video as reference.
4. Learners write their own 5-sentence narrative using the same structure.
5. Share with a partner.

Why It Works: Animated narrative scaffolds writing structure by giving learners a visual-audio model of story architecture before they write independently.

LESSON IDEA:

Science – Weather Elements with Interactive Video Module (Science, Grade 4)

Objective: Learners describe and classify weather elements (temperature, cloud cover, wind, precipitation).

Multimedia Tool: Subject-specific video clip on weather – embedded reflection prompts.

Process:
1. Show video clip with pause points.
2. At each pause, pose a reflective question: "Why does rain fall?" "What causes wind?"
3. Learners record answers in a science journal.
4. Groups create a weather chart using data from the video.
5. Present findings to the class.

Why It Works: Combines subject-specific video (visual modeling) with reflective prompts (higher order thinking) and collaborative task completion.

D Grades5-6 (Ages 10–12)

Grades 5–6 learners are developing the metacognitive and critical thinking capacities needed for independent academic inquiry. Multimedia at this stage should challenge learners to investigate, evaluate, create, and communicate. The most effective formats are those that give learners agency over their learning while embedding structured inquiry demands (Jalmasco et al., 2025; Alyasfan et al., 2024; Yoranda et al., 2024; Arslan, 2025).

Challenges and Strategies

Challenge Learners rush through e-modules without reading or reflecting.

Strategy Embed checkpoints with open-ended questions that cannot be skipped. Pair module completion with a written exit ticket or class discussion. Use progress data to identify who needs re-teaching.

Challenge 3D modeling and creative tools produce frustration for learners with low digital literacy.

Strategy Provide a structured tutorial video before independent work. Pair more experienced digital users with developing users. Focus on design thinking process, not tool perfection.

Challenge YouTube discovery videos lead learners off-task to entertainment content.

Strategy Pre-select and embed specific clips in an e-module or LMS. Provide a guided inquiry worksheet that focuses attention on specific content. Discuss media quality criteria explicitly.

Best Multimedia Formats

- Discovery-Based YouTube Videos
- Student Produced Videos

- Self-Directed Interactive E-Modules
- Creative 3D Modeling and AR Tools
- Multimedia Vocabulary Tools (CAP-S, TikTok)
- Affective Design Multimedia (Quizizz, Wordwall)

Topics with Appropriate Multimedia Tools (Grades 3-4)

Learning Area	Competency	Suggested Multimedia Tool
SCIENCE	Explain the process of heat transfer (conduction, convection, radiation) with examples from daily life.	Discovery-based YouTube video (guided investigation); interactive e-module with PhET simulations.
ENGLISH	Write a persuasive essay on a relevant social issue; use evidence-based arguments with proper structure.	TikTok integrated vocabulary instruction; multimedia vocabulary tool (CAP-S type); student video project.
MATHEMATICS	Solve problems involving fractions, decimals, and percentages in real-world contexts.	Self directed interactive e-module with branching problem paths; Quizizz/ Wordwall gamified review.
EPP/TLE	Design and create a functional product using available local materials; apply design thinking processes.	Creative 3D modeling tool; AR based design activity; student produced video documentation of process.
ARALING PANLIPUNAN (GRADE 6)	Analyze the causes and effects of Philippine independence movements; evaluate primary sources.	Discovery-based documentary video; interactive digital timeline; collaborative video analysis project.

Sample Classroom Application

LESSON IDEA:

Science – Weather Elements with Interactive Video Module (Science, Grade 5)

Objective: Learners explain three types of heat transfer with real-life examples.

Multimedia Tool: Curated YouTube video + guided inquiry worksheet.

Process:
1. Teacher poses inquiry question: "How does heat move from one place to another?"
2. Learners watch designated YouTube video with a guiding question sheet.
3. Groups investigate one type of heat transfer each, using the video as a primary source.
4. Groups produce a short visual summary (drawing + label or digital infographic).
5. Gallery walk and peer feedback.

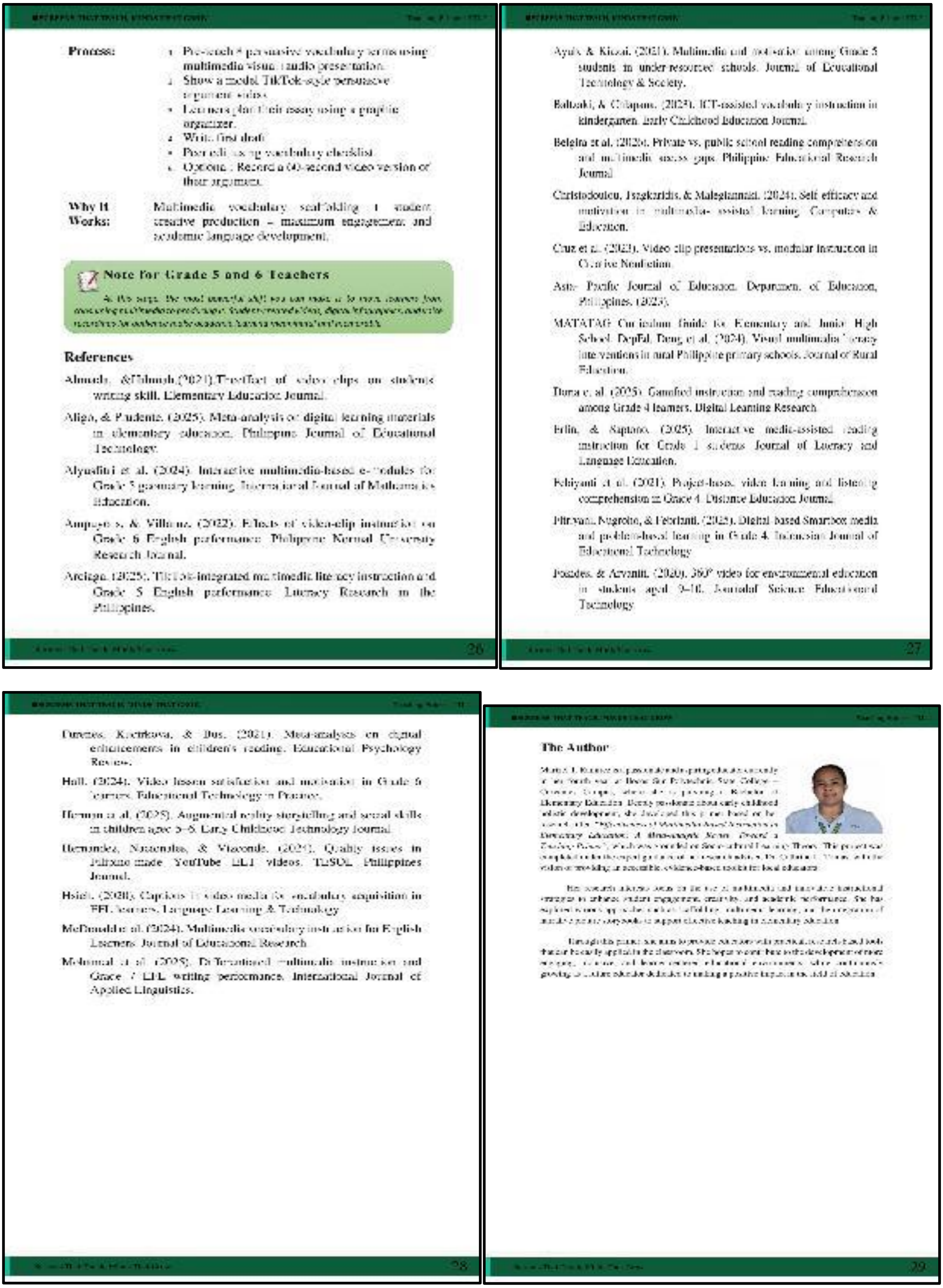
Why It Works: Discovery based video at this stage functions as a scaffold for guided inquiry, not passive viewing but active investigation using video as evidence.

LESSON IDEA:

Science – Persuasive Writing with Multimedia Vocabulary Support (English, Grade 6)

Objective: Learners write a 3-paragraph persuasive essay using precise academic vocabulary.

Multimedia Tool: CAP-S-type vocabulary video instruction + TikTok vocabulary model clips (teacher- curated).


Process:
1. Pre-teach 8 persuasive vocabulary terms using multimedia visual/audio presentation.
2. Show a model TikTok-style persuasive argument video.
3. Learners plan their essay using a graphic organizer.
4. Write first draft.
5. Peer edit using vocabulary checklist.
6. Optional: Record a 60-second video version of their argument.

Why It Works: Multimedia vocabulary scaffolding + student creative production = maximum engagement and academic language development.

Note for Grade 5 and 6 Teachers

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The Author

Figure 8: Evidence-Based Teaching Primer

CONCLUSIONS

Based on the results, the following conclusions were drawn:

1. Multimedia has a generally positive effect on learners, particularly along academic performance, engagement, and understanding. However, its effectiveness depends on proper design, teacher guidance, and active learner participation.
2. Different multimedia tools are appropriate for different developmental stages. Simple and visual tools are more effective for younger learners, while interactive and complex tools are more suitable for older learners. This shows the importance of aligning multimedia with learners' developmental needs.
3. Existing research on multimedia learning is limited by several key issues, including small sample sizes, weak or non-randomized research designs, short intervention periods, shallow measurement approaches, and limited access to technology. These limitations reduce the reliability and strength of the findings and make it difficult to generalize the results across different grade levels, subjects, and educational contexts.
4. An evidence-based teaching primer is necessary to guide teachers in using multimedia effectively. The primer provides practical strategies based on research findings and supports the integration of multimedia in teaching.

RECOMMENDATIONS

1. Teachers may integrate multimedia as an instructional tool to enhance learners' academic performance and engagement. However, the use of multimedia may be guided by careful planning, clearly defined learning objectives, and the application of active and student-centered learning strategies to ensure its effectiveness.
2. Teachers may select multimedia tools that are developmentally appropriate for their learners. At the same time, schools may provide adequate support by promoting the use of diverse multimedia resources that are suitable for different grade levels and learning needs.
3. Future researchers may employ more rigorous research designs, larger and more diverse sample sizes, and longer intervention periods in order to produce more reliable and generalizable findings. In addition, schools and policymakers may strengthen access to technology and provide continuous professional development and training for teachers on effective multimedia integration. To improve comprehensiveness, future iterations of this study should expand database coverage to include Scopus, Web of Science, and other international indexing platforms. Additionally, the inclusion of non-English studies would reduce language bias and provide a more globally representative synthesis of multimedia effectiveness.
4. Teachers may use the developed teaching primer as a practical guide in integrating multimedia into classroom instruction. Future studies may further refine, validate, and test the effectiveness of the primer across different grade levels and educational settings. To enhance data visualization in future research, graphical representations such as forest plots and funnel plots may be incorporated to illustrate effect size distribution and potential publication bias.

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