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Enhancing Grade 9 Learners' Science Achievement and Metacognition Through Structured Digital Learning Episodes

Marie Lou J. Romero[1,2 *], Raymund B. Bolalin[2]
[1] *Department of Education – Schools Division Office of Manila, Carlos P. Garcia High School*
[2] *Eulogio "Amang" Rodriguez Institute of Science and Technology (EARIST) – Manila*
[*] *marielou.romero001@deped.gov.ph, rbbolalin@earist.edu.ph*

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ABSTRACT

This study was conducted to address the increasing need for innovative digital instructional approaches to enhance learners' science achievement and metacognition in Grade 9 Science. Specifically, it aimed to determine the extent of utilization of technology-assisted instructional strategies, identify the challenges encountered by science teachers, develop Structured Digital Learning Episodes (SDLE), assess their acceptability, and determine their effectiveness in improving learners' science achievement and metacognition. The study employed a Research and Development (R&D) design consisting of descriptive survey, thematic analysis, developmental research, descriptive-evaluative research, and one-group pretest-posttest phases. The study was conducted in District VI, Division of the City of Manila. Respondents included 38 science teachers for the needs assessment, science teachers and experts for acceptability evaluation, and 80 Grade 9 learners for pilot testing. Purposive sampling was employed. Instruments included a utilization and challenges survey, an acceptability questionnaire, the Science Achievement Test, and the Metacognition Questionnaire. Data were analyzed using weighted mean, rank, grand mean, frequency, percentage, mean, standard deviation, Shapiro–Wilk test, and Wilcoxon Signed-Rank Test. Findings revealed that technology-assisted instructional strategies were generally utilized, although several implementation challenges were identified. The developed SDLE was rated highly acceptable across all criteria. Significant improvements were observed in learners' science achievement, knowledge of cognition, and cognitive regulation after using the SDLE. The study concluded that SDLE is an effective and acceptable instructional innovation for enhancing science achievement and metacognition among Grade 9 learners.

Keywords: *Structured Digital Learning Episodes, science achievement, metacognition, Grade 9 Science, instructional material development*

INTRODUCTION

Digital learning has become an essential component of contemporary education as schools increasingly integrate technology to enhance teaching and learning processes. It utilizes digital tools and resources to support instructional delivery, promote learner engagement, and provide flexible learning opportunities. In today's educational landscape, digital learning plays a significant role in creating learner-centered environments that respond to diverse learning needs and improve academic performance.

In the Philippine basic education system, the integration of digital learning is supported by national policies and curriculum reforms. The Department of Education promotes the use of technology through initiatives such as the Digital Rise Program and the Basic Education Learning Continuity Plan. These programs aim to strengthen the delivery of quality education, ensure continuity of learning, and develop learners' digital competencies necessary for the 21st century. The K to 12 Science Curriculum further emphasizes the need for innovative instructional approaches that promote deeper understanding and higher-order thinking skills.

Despite these efforts, science education continues to present significant challenges. Science is widely recognized as a cognitively demanding subject that involves abstract concepts and complex processes. Many learners have trouble understanding scientific ideas, particularly when instruction relies on traditional methods. As a result, gaps in learners' conceptual understanding and critical thinking skills persist, and teachers encounter difficulties in presenting lessons in engaging and effective ways.

To address these challenges, structured digital learning approaches have been introduced as an innovative instructional strategy. Structured Digital Learning Episodes organize digital content into coherent lessons supported by guided activities, assessments, and feedback. These episodes integrate multimedia elements and interactive tasks to enhance learners' understanding of scientific concepts while encouraging active participation.

This study focuses on two major variables: Structured Digital Learning Episodes as the instructional intervention, and science achievement and metacognition as the learning outcomes. Science achievement refers to learners' ability to understand and apply scientific knowledge, while metacognition refers to their ability to plan, monitor, and evaluate their own learning. These variables are important in determining how instructional strategies influence both academic performance and self-regulated learning.

The use of Structured Digital Learning Episodes is justified by the need to improve both cognitive and metacognitive aspects of learning. This approach supports a deeper understanding and promotes learners' awareness of their learning processes, both of which are essential in science education.

However, few studies have examined the combined effects of structured digital learning approaches on both science achievement and metacognition, particularly in the Philippine public school context. This gap highlights the need for further investigation into the effectiveness of integrated digital instructional strategies.

In view of this, the study aims to assess the effectiveness of Structured Digital Learning Episodes in improving the science achievement and metacognition of Grade 9 learners. The findings are expected to improve science instruction and guide the development of structured digital learning interventions in basic education.

Theoretical Framework

This study was anchored on the Cognitive Theory of Multimedia Learning (CTML) by Richard E. Mayer (2021). CTML explains how learners learn more effectively from instructional materials that combined words, images, animations, videos, and other multimedia elements than from words alone. The theory rests on three assumptions on three major assumptions: dual-channel processing, which posited that learners processed information through separate visual and auditory channels; limited capacity, which suggested that each channel could process only a limited amount of information at a given time; and active processing, which maintained that meaningful learning occurred when learners actively selected, organized, and integrated information with their prior knowledge.

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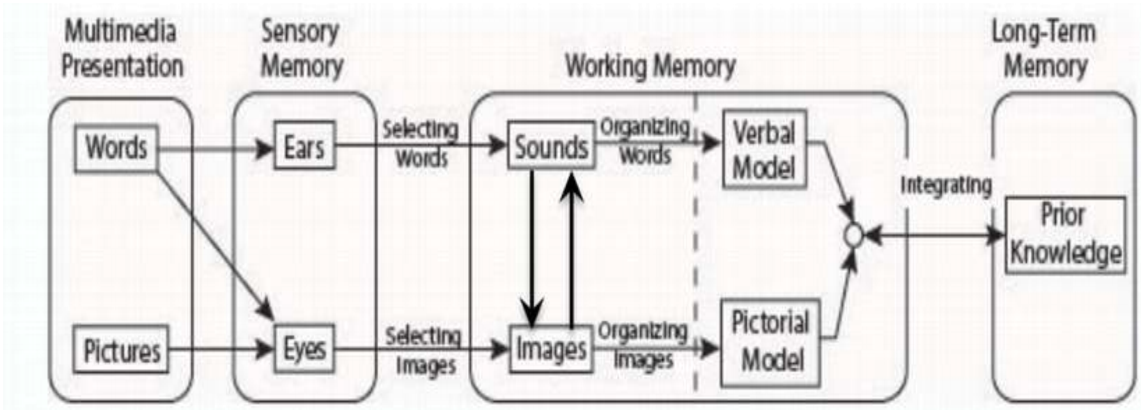

Figure 1. *Cognitive Theory of Multimedia Learning*
Source: Adapted from Using PowerPoint effectively—Accessibility reply by James Madison University (2018)

The Cognitive Theory of Multimedia Learning posits that information enters sensory memory through visual and auditory inputs. Relevant information is selected and processed in working memory, where learners organize it into coherent verbal and pictorial mental models. These mental models are subsequently integrated with prior knowledge stored in long-term memory, resulting in meaningful learning. Mayer (2021) argued that effective multimedia instruction facilitates this process by minimizing extraneous cognitive load and directing learners' attention toward essential information.

The Cognitive Theory of Multimedia Learning served as the theoretical foundation for the present study, as the Structured Digital Learning Episodes (SDLEs) were designed using multimedia elements such as text, graphics, videos, interactive activities, formative assessments, and feedback mechanisms. These features reflect the principles of CTML by presenting scientific concepts through multiple representations and guiding learners through structured learning experiences. Through this process, learners are expected to develop deeper conceptual understanding, which could lead to improved science achievement.

The theory also provides a basis for explaining the development of metacognition. As learners engaged with structured multimedia lessons, completed guided activities, responded to formative assessments, and received feedback, they were encouraged to monitor their understanding, evaluate their progress, and adjust their learning strategies as needed. These processes reflected important metacognitive skills, including planning, monitoring, and self-evaluation. Consequently, CTML explained not only how SDLEs supported knowledge acquisition but also how they fostered learners' awareness and regulation of their own learning processes.

Recent studies continue to support Mayer's theory in digital learning environments, demonstrating that well-designed multimedia instruction improves academic achievement and promotes self-regulated learning among secondary school learners. These findings suggested that structured multimedia-based instruction was particularly effective in science education, where learners often encountered abstract concepts that required multiple forms of representation for meaningful understanding.

The application of CTML in this study was further supported by educational policies in the Philippines. The K to 12 Science Curriculum (DepEd, 2016) emphasized inquiry-based and learner-centered approaches that promoted conceptual understanding and higher-order thinking skills. Similarly, the Basic Education Learning Continuity Plan (DepEd, 2020) and subsequent digital education initiatives advocated integrating technology-enhanced instructional strategies to improve learning outcomes. The use of SDLEs aligned with these policy directions by providing structured digital instruction designed to enhance both science achievement and metacognition among Grade 9 learners.

Therefore, the Cognitive Theory of Multimedia Learning served as the principal theoretical lens of

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Volume 2 Issue 8 (August 2026)

the study. It explained how Structured Digital Learning Episodes could improve science achievement through meaningful multimedia learning experiences while simultaneously fostering metacognitive processes that enabled learners to become more effective and self-regulated learners.

Conceptual Framework

The conceptual framework of the study is presented in Figure 2. It illustrates the relationships among the major components of the research using the Input–Process–Output (IPO) Model. The framework shows how the inputs, consisting of curriculum requirements, theoretical foundations, baseline learner data, and stakeholder inputs, were utilized in the development and implementation of the Structured Digital Learning Episodes (SDLE). It further depicts the processes involved in the design, validation, implementation, assessment, and revision of the intervention.

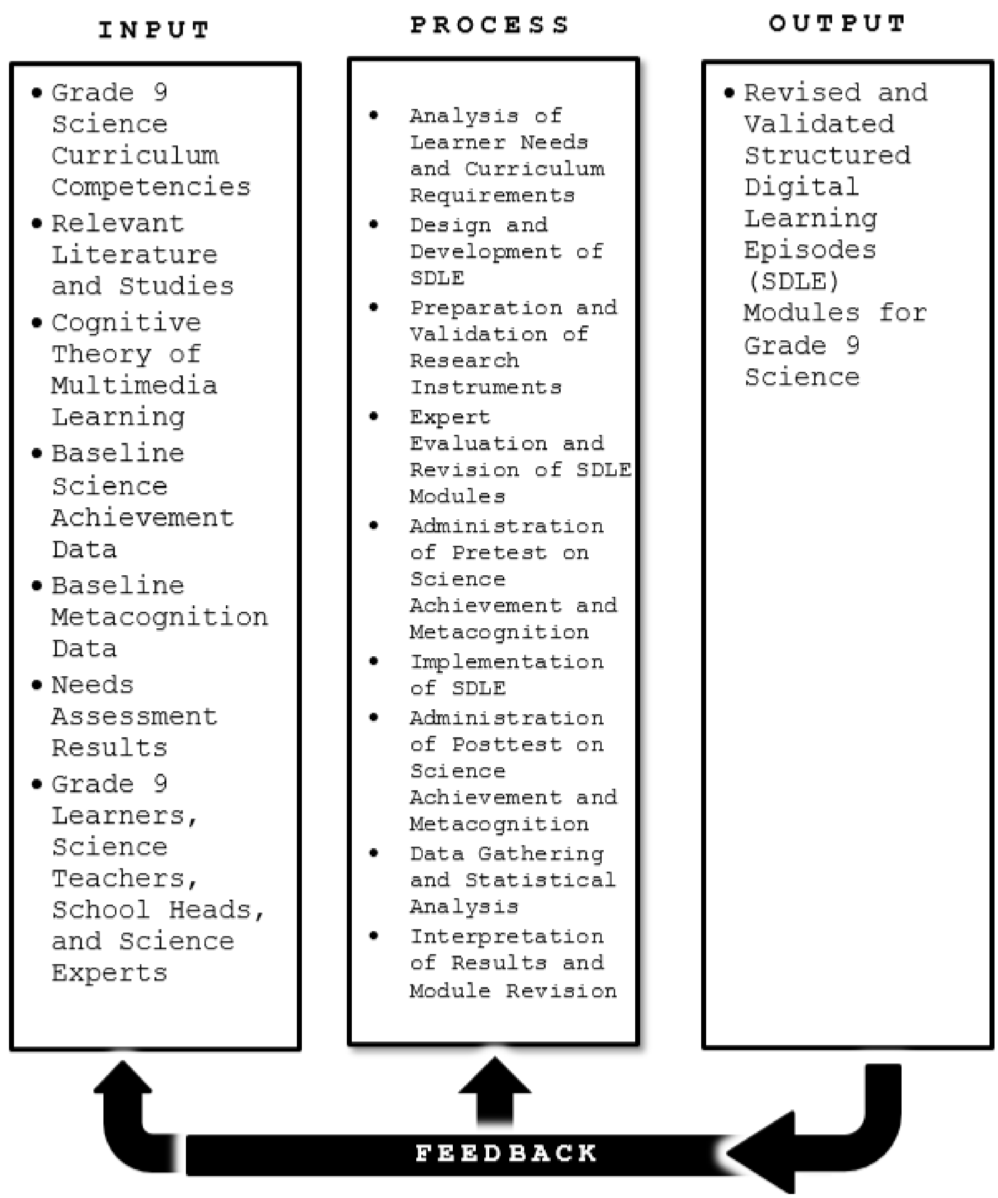

Figure 2. *Research Paradigm*

The *input phase* consisted of the resources and information necessary for the development of the Structured Digital Learning Episodes. These included the K to 12 Science Curriculum competencies, relevant literature and studies, the Cognitive Theory of Multimedia Learning, baseline data on learners' science achievement and metacognition, results of the needs assessment, and inputs from Grade 9 learners, science teachers, science experts, and school heads. These elements provided the theoretical, curricular, and empirical foundations for the development of the intervention.

The *process phase* involved the systematic procedures undertaken in the conduct of the study. These included the analysis of learner needs and curriculum requirements, the design and development of the Structured Digital Learning Episodes using the 7E instructional sequence and the Science Metacognition Through Structured Digital Learning Episodes Learning Framework, the preparation and validation of research instruments by subject matter experts, expert evaluation of the developed modules, implementation of the intervention during the Fourth Quarter of School Year 2025–2026, administration of pretests and posttests on science achievement and metacognition, presentation of data through tables and statistical analysis, interpretation of results, and revision of the modules based on the findings obtained.

The *output phase* consisted primarily of the revised and validated Structured Digital Learning Episodes (SDLE) Modules entitled "Science Metacognition Through Structured Digital Learning Episodes," which served as the final instructional product of the developmental research. The effectiveness of these modules was reflected in their ability to improve learners' science achievement and metacognition, the two outcome variables examined in the study.

The framework likewise incorporated a *feedback mechanism*, which demonstrated the cyclical nature of instructional material development. Findings from the implementation, evaluation, and assessment of learner outcomes were used to refine the content, activities, assessments, and delivery features of the SDLE modules. Through this process, the intervention was continuously improved to ensure its quality, relevance, and effectiveness in supporting science learning and metacognitive development.

Statement of the Problem

This study developed, validated, and evaluated Structured Digital Learning Episodes (SDLE) for Grade 9 Science in the Division of the City of Manila. Specifically, it determined the extent of utilization of Structured Digital Learning Episodes, identified the challenges encountered by science teachers in using them, developed and validated SDLE based on the identified needs, and assessed their effectiveness in enhancing the science achievement and metacognition of Grade 9 learners.

Specifically, it sought answers to the following questions:

1. What is the extent of utilization of Structured Digital Learning Episodes for Grade 9 Science learners in District VI, Division of the City of Manila?
2. What are the challenges encountered by science teachers in using Structured Digital Learning Episode (SDLE)?
3. Based on the findings, what SDLE modules may be proposed?
4. How do the science teachers and experts assess the acceptability of SDLE modules in terms of:
   4.1. objectives;
   4.2. content;
   4.3. activities;
   4.4. usefulness;
   4.5. language and style;
   4.6. organization;
   4.7. presentation;
   4.8. evaluation; and,
   4.9. navigation?
5. Is there a significant difference between the Grade 9 learners' achievement and metacognition before and after using the SDLE?

Literature Review

Local Literature

The integration of digital technology into basic education has become a major educational priority in the Philippines. Recognizing the need to improve educational quality and address persistent learning gaps, the Department of Education (DepEd, 2020) institutionalized various technology-supported learning modalities through the Basic Education Learning Continuity Plan. The policy emphasized the use of digital resources and technology-enhanced instruction to ensure continuous access to quality education and support learner engagement across different learning environments. The policy is relevant to the present study because the development of Structured Digital Learning Episodes (SDLE) aligns with the Department's efforts to strengthen technology-supported instruction and improve learning outcomes.

To further advance educational digitalization, the Department of Education launched the Digital Rise Program, which aims to accelerate digital transformation in Philippine basic education by improving digital infrastructure, instructional resources, and teacher capacity-building initiatives (DepEd, 2022). The program recognizes the importance of digital instructional materials in supporting effective teaching and learning. This initiative provides policy support for developing SDLE as a structured digital instructional resource to enhance learners' science achievement and metacognition.

The K to 12 Science Curriculum Guide likewise emphasizes the development of scientifically literate learners who can apply scientific concepts, solve problems, and engage in critical thinking (DepEd, 2016). The curriculum recommends using varied instructional approaches that encourage active participation and meaningful learning. Because many Grade 9 science concepts involve abstract phenomena and complex processes, the curriculum supports the integration of multimedia and technology-enhanced instructional strategies such as SDLE. This curriculum mandate directly supports the implementation of the intervention developed in the present study.

Similarly, the Commission on Higher Education (CHED, 2020) highlighted the importance of flexible learning environments characterized by instructional coherence, learner engagement, and purposeful use of technology. Although intended primarily for higher education institutions, the principles articulated in the guidelines reinforce the value of structured and well-designed digital learning experiences across educational levels. The emphasis on instructional design and learner-centered approaches supports the rationale for developing structured digital learning materials that address diverse learner needs.

Several local studies have documented the growing importance of technology integration in improving educational outcomes. Sasota et al. (2021) developed the Will–Skill–Tool Model of technology integration among science and mathematics teachers in the Philippines and found that successful technology integration depended on teachers' willingness, technological competence, and access to digital resources. Their findings suggest that carefully designed digital instructional materials can enhance teaching effectiveness and learner performance when properly implemented. These results support the use of SDLE as a structured technology-based intervention in science instruction.

The challenges associated with digital learning have also been highlighted in local literature. Santos (2021) reports that limited access to technology, inadequate internet connectivity, and disparities in digital resources contributed to learning difficulties among Filipino learners. The study emphasizes that digital learning interventions must be systematically designed to maximize learning opportunities and minimize barriers to learning. This observation underscores the importance of developing organized and accessible instructional materials, such as SDLE, that can support learners regardless of varying levels of technological access.

Evidence regarding science achievement among Filipino learners likewise highlights the need for innovative instructional interventions. Results of the Programme for International Student Assessment (PISA) 2022 revealed that Filipino learners continued to perform below the international average in science literacy (OECD, 2023). The findings suggest persistent challenges in learners' understanding and application of scientific concepts. Given these concerns, instructional innovations that support deeper conceptual understanding and active engagement are needed to improve science achievement among secondary school learners.

Local studies further indicate that technology-supported learning experiences can positively influence science achievement. Padios (2023) examined the effects of distance laboratory experiences on senior high school learners' physics achievement and found that students exposed to technology-enhanced laboratory activities achieved better than those who relied solely on traditional instructional approaches. The study suggests that well-designed digital learning experiences can facilitate science learning and improve academic performance. These findings support the potential effectiveness of SDLE in enhancing Grade 9 learners' science achievement.

Apart from academic performance, current educational research emphasizes the importance of metacognition in promoting effective learning. Metacognition enables learners to plan, monitor, and evaluate their own learning processes, thereby supporting self-regulated learning and academic success. In a Philippine study, Torres and Orleans (2021) explored metacognition in science teaching and found that metacognitive processes significantly improved instructional practices and learner outcomes. Their findings highlight the importance of incorporating activities that encourage learners to reflect on and regulate their own learning, a feature embedded in the SDLE developed in the present study.

Similarly, Saguna and Prudente (2021) examined the application of metacognitive orientation standards in science classrooms and reported improvements in learner engagement, reflection, and higher-order thinking skills. The researchers concluded that learning environments intentionally designed to promote metacognitive processes can contribute to more meaningful learning experiences. These findings provide support for the inclusion of reflective and self-monitoring activities in the SDLE.

Biscocho (2021) investigated the metacognitive knowledge, skills, and attitudes of students enrolled in Science, Technology, and Society courses and found that learners with stronger metacognitive abilities demonstrated greater independence and effectiveness in learning. The study recommended integrating metacognitive strategies into instructional materials and classroom activities. This recommendation is directly reflected in the design of the SDLE, which incorporates opportunities for planning, monitoring, and evaluating learning.

Likewise, Santiago and Dagdag (2021) examined the influence of instructional approaches on science achievement and metacognitive learning orientations among elementary learners. Their findings demonstrated that instructional interventions can simultaneously affect learners' academic performance and metacognitive development. The study is particularly relevant to the present investigation because it supports the examination of science achievement and metacognition as complementary learning outcomes.

Ellado (2021) further emphasized the value of metacognitive practices in education by examining the relationship between teachers' metacognition and learners' higher-order thinking skills. Although the relationships varied across variables, the study highlighted the importance of fostering metacognitive awareness to improve learning outcomes. The findings reinforce the need for instructional materials that intentionally develop learners' metacognitive abilities alongside content mastery.

Collectively, these local literature sources demonstrate the growing emphasis on digital learning, science achievement, and metacognitive development within Philippine education. They provide a strong policy, curricular, and empirical foundation for the development and implementation of Structured Digital Learning Episodes among Grade 9 learners.

Foreign Literature

The rapid advancement of digital technologies has transformed educational practices worldwide, leading to increased interest in technology-enhanced learning environments. International organizations have emphasized the role of digital learning in improving educational access, learner engagement, and academic achievement. The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023) highlighted that digital learning environments provide opportunities for personalized instruction, collaborative learning, and the development of higher-order thinking skills. UNESCO further noted that

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Volume 2 Issue 8 (August 2026)

well-designed digital learning resources can support learners in constructing knowledge actively rather than passively receiving information. These observations support the development of Structured Digital Learning Episodes (SDLE) as an instructional approach intended to promote meaningful science learning.

Similarly, the Organization for Economic Co-operation and Development (OECD, 2021) emphasized that effective use of digital technologies can enhance learning when instructional materials are intentionally designed to support cognitive engagement and self-regulated learning. The report stressed that educational technologies are most effective when accompanied by appropriate pedagogical structures that guide learners through complex learning tasks. This perspective is consistent with the present study, which utilizes SDLE as structured instructional materials designed to support both science achievement and metacognition.

Research on digital learning has increasingly focused on the importance of instructional design. Hodges et al. (2020) argued that the effectiveness of technology-based learning depends not merely on the availability of digital tools but on the quality of instructional planning and design. According to the authors, carefully structured digital learning experiences provide learners with clear objectives, organized content, meaningful activities, and opportunities for feedback. Their work supports the premise that structured digital learning environments can facilitate improved learning outcomes.

Studies have also highlighted the value of multimedia learning in science education. Mayer (2021) explained that learners acquire knowledge more effectively when information is presented through carefully integrated verbal and visual representations. The Cognitive Theory of Multimedia Learning suggests that multimedia instruction promotes meaningful learning by helping learners organize and integrate information while minimizing unnecessary cognitive load. This principle is particularly relevant to science education, where abstract concepts often require multiple forms of representation. The SDLE developed in the present study incorporates multimedia elements guided by these principles to facilitate learners' understanding of Grade 9 science concepts.

The importance of digital learning for improving academic achievement has been documented in numerous international studies. Sung et al. (2019) found that technology-supported instruction significantly improved learners' academic performance across various subject areas when instructional activities were aligned with learning objectives. The researchers concluded that educational technologies can enhance achievement when used within well-structured instructional frameworks. Their findings support the use of SDLE to improve science achievement among Grade 9 learners.

Likewise, Bond et al. (2021) reported that digital learning environments positively influenced learner engagement, participation, and academic performance when instructional activities encouraged active involvement in learning. The study emphasized that meaningful interaction with content and learning tasks contributes to deeper understanding and improved achievement. These findings reinforce the importance of incorporating interactive, learner-centered activities into SDLE.

In science education, digital learning has been shown to improve conceptual understanding and performance. A systematic review conducted by García-Martínez et al. (2023) revealed that technology-enhanced science instruction contributed to significant gains in students' academic achievement, particularly when digital tools were used to support inquiry, visualization, and problem-solving activities. The review suggested that structured digital learning environments are especially beneficial for teaching complex scientific concepts. This finding supports the use of SDLE in facilitating learners' mastery of Grade 9 science competencies.

Apart from improving academic achievement, contemporary educational research recognizes metacognition as a critical factor in successful learning. Metacognition enables learners to regulate their cognitive processes through planning, monitoring, and evaluation, thereby enhancing learning effectiveness. Veenman et al. (2017) emphasized that metacognitive skills are strong predictors of academic success because they enable learners to manage their learning strategies and adapt to changing learning demands. Their work highlights the importance of incorporating metacognitive opportunities into instructional materials and learning activities.

Research has shown that digital learning environments can support the development of metacognition when instructional designs intentionally promote self-regulated learning. Dignath and Veenman (2021) reported that learners who received explicit support for metacognitive regulation demonstrated better academic performance and greater independence in learning than those who did not. The authors emphasized the value of instructional interventions that encourage learners to plan, monitor, and evaluate their learning processes. These findings support the inclusion of reflective and self-monitoring components within the SDLE.

Similarly, Azevedo and Gašević (2019) observed that digital learning environments can foster metacognitive development by providing learners with opportunities to reflect on their learning progress, evaluate their understanding, and adjust learning strategies. The study highlighted the role of technology in facilitating self-regulated learning and emphasized the need for instructional designs that actively promote metacognitive engagement. This perspective is reflected in the structure of the SDLE, which incorporates activities designed to strengthen learners' metacognitive skills.

Further evidence was provided by Schraw et al. (2024), who emphasized that metacognitive regulation significantly contributes to learners' ability to solve problems, transfer knowledge, and achieve academic success. The authors argued that educational interventions should intentionally develop learners' planning, monitoring, and evaluation skills alongside content knowledge. Their findings support the dual focus of the present study on science achievement and metacognition.

The relationship between digital learning and metacognition has also been documented in studies involving self-regulated learning environments. Panadero et al. (2022) found that technology-supported instructional interventions that incorporated reflection, feedback, and self-assessment opportunities significantly enhanced learners' metacognitive awareness and learning performance. These findings suggest that structured digital learning environments can simultaneously support academic achievement and metacognitive development, which are the primary outcomes examined in the present study.

Collectively, the reviewed foreign literature provides substantial evidence that structured digital learning environments can improve academic achievement and foster metacognitive development. The literature further underscores the importance of instructional design, multimedia integration, learner engagement, and self-regulated learning in maximizing the educational benefits of digital technologies. These findings provide strong theoretical and empirical support for the development and implementation of Structured Digital Learning Episodes among Grade 9 learners.

Local Studies

Recent Philippine studies have highlighted the growing importance of metacognition and technology-enhanced learning in improving students' academic performance and self-regulated learning. These investigations provide empirical support for the development of instructional interventions designed to enhance learners' cognitive and metacognitive outcomes.

Zhan (2022) explored the metacognition of Grade 9 students during mathematical problem solving through a qualitative case study involving learners with varying levels of problem-solving ability. The findings revealed that while learners generally demonstrated strong planning skills, many experienced difficulties in monitoring and evaluating their thinking processes during problem solving. The study emphasized the importance of instructional interventions that explicitly develop metacognitive regulation. The findings are relevant to the present study because the Structured Digital Learning Episodes (SDLE) were designed to provide opportunities for planning, monitoring, and evaluating learning, which are key dimensions of metacognition.

Modesto (2025) investigated the effects of shared metacognition within a Community of Inquiry framework on the physics performance of senior high school students in a blended learning environment. Using a mixed-methods approach, the study found significant improvements in both conceptual understanding and problem-solving performance following the implementation of metacognitive learning strategies. Students also reported enhanced reflection, confidence, and collaborative learning experiences. These findings suggest that structured learning environments that promote metacognitive engagement can improve science learning outcomes, supporting the rationale for integrating metacognitive components into the SDLE.

Necio (2025) examined the relationship between science achievement and metacognitive strategies among Grade 9 learners. The study reported a positive relationship between learners' use of metacognitive strategies and their academic performance in science. Students who demonstrated stronger planning, monitoring, and evaluation skills tended to achieve higher science scores. The findings underscore the importance of developing metacognitive competencies as a means of improving science achievement, which directly supports the dual focus of the present study on science achievement and metacognition.

Madiclum (2026) developed and validated a Science Process Skills Proficiency Assessment intended to enhance science instruction and learner performance. The study emphasized the importance of systematically developed and validated instructional and assessment materials in improving science learning outcomes. The research is related to the present study because both investigations involved the development, validation, and evaluation of educational materials intended to improve science learning.

Abareta (2025) developed and implemented instructional videos generated through artificial intelligence to improve learners' understanding of the nature of science. Results indicated that multimedia-based instructional resources contributed positively to students' conceptual understanding and engagement. The study demonstrated the potential of digital learning materials to support science education and provided evidence that technology-enhanced instructional resources can improve learning outcomes. These findings support the use of SDLE as a structured digital intervention for Grade 9 Science.

Rayyanah (2025) developed, validated, and implemented a STEM teaching kit to support junior high school physics teachers who teach outside their specialization. The study found that carefully designed instructional materials improved teaching effectiveness and enhanced learners' engagement and understanding of scientific concepts. The findings highlight the value of systematically developed instructional resources and support the developmental nature of the present study, which likewise focuses on the design, validation, and implementation of instructional materials.

Buera (2017) examined the effects of the Metacognitive-Creative Problem-Solving Method on Grade 9 students' metacognition, conceptual understanding, and physics performance. The results showed significant improvements in learners' metacognitive awareness and academic achievement following exposure to metacognitive instructional strategies. The study demonstrated the strong relationship between metacognitive development and science achievement and provided empirical support for instructional interventions that intentionally cultivate both outcomes.

Collectively, these local studies provide evidence that metacognitive strategies, technology-enhanced learning environments, and systematically developed instructional materials can positively influence learners' academic performance and self-regulated learning. The findings further suggest that instructional interventions that integrate structured learning experiences and opportunities for reflection have the potential to improve both science achievement and metacognition among secondary school learners.

Foreign Studies

Recent foreign dissertations and theses have consistently emphasized the role of structured digital learning environments, metacognitive development, and instructional design in improving learners' academic achievement, particularly in science-related disciplines.

Broadbent (2021) examined self-regulated learning in online environments and found that metacognitive strategies such as planning, monitoring, and evaluation were strong predictors of academic success in digital learning settings. The study highlighted the importance of structured learning systems that explicitly guide learners in regulating their cognition.

Similarly, Zheng (2021), based in the United States, investigated online learning design in K–12 science education and reported that structured digital instruction significantly improved student engagement and conceptual understanding when combined with scaffolded activities and feedback mechanisms.

Kim and Xie (2021), in a study conducted in South Korea, examined digital science learning environments and found that multimedia-supported instruction improved science achievement when cognitive load was effectively managed through structured content sequencing.

A dissertation by Alqurashi (2022) in Saudi Arabia explored student engagement in online learning and concluded that perceived learning effectiveness was strongly associated with structured instructional design and metacognitive engagement.

In the United Kingdom, Jones (2022) investigated metacognitive scaffolding in blended science classrooms and found significant improvements in learners' ability to regulate their thinking and improve academic performance in science subjects.

A study by Miller (2022) in the United States examined digital instructional modules in middle school science and found that structured learning episodes enhanced learners' achievement scores compared to traditional instruction.

Garcia (2022) in Spain explored multimedia-based science instruction and concluded that learners exposed to structured digital lessons performed significantly better in conceptual understanding and problem-solving tasks.

In Canada, Thompson (2022) investigated metacognitive prompts on digital learning platforms and found that learners demonstrated higher levels of self-monitoring and improved science achievement.

Williams (2023) from the United States examined the impact of instructional design in virtual science laboratories and found that structured digital environments improved inquiry skills and conceptual retention.

Brown (2023), in the United Kingdom, studied blended learning in secondary science education and reported that the structured sequencing of digital content significantly improved student achievement and engagement.

Lee (2023) in Singapore examined digital science modules and found that learners who used structured multimedia lessons demonstrated higher metacognitive awareness and better academic performance.

Chen (2023), in Taiwan, investigated metacognitive regulation in online STEM learning and found that students who engaged in guided reflection activities performed significantly better on science assessments.

Anderson (2023) in Australia studied digital inquiry-based science learning and concluded that structured scaffolding improved learners' conceptual understanding and self-regulation.

Taylor (2023), in the United States, explored adaptive learning systems in science education and found that personalized, structured digital instruction significantly improved academic achievement.

Martin (2023), in France, examined cognitive load management in multimedia science learning and found that structured instructional design improved knowledge retention and transfer.

In the United States, Johnson (2024) investigated learning analytics-supported science instruction and found that feedback-driven, structured digital learning improved both metacognition and achievement.

Smith (2024) in Canada studied self-regulated learning in virtual classrooms and reported that metacognitive training significantly improved learners' science performance.

Wilson (2024) in the United Kingdom examined digital formative assessment tools and found that structured feedback systems enhanced learners' metacognitive regulation and academic outcomes.

Davis (2024) in Australia investigated interactive science simulations and found that structured digital environments improved conceptual understanding and learner engagement.

Nguyen (2024) in Vietnam studied blended STEM learning environments and concluded that structured instructional sequences improved both science achievement and metacognitive awareness.

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Volume 2 Issue 8 (August 2026)

Finally, Roberts (2025) in the United States examined AI-supported learning environments and found that structured digital learning pathways significantly improved student achievement and metacognitive monitoring in science learning contexts.

Collectively, these foreign studies consistently demonstrate that structured digital learning environments, when designed with cognitive and metacognitive supports, significantly improve science achievement and learners' ability to regulate their own learning processes. However, most studies focus either on higher education or on general STEM contexts, indicating a need for localized, structured digital interventions specifically designed for junior high school science learners, such as Structured Digital Learning Episodes (SDLE).

Synthesis

The reviewed literature and studies, both local and foreign, consistently converge on three major themes: the increasing role of structured digital learning environments, the importance of metacognitive development, and the persistent need to improve learners' science achievement. These themes collectively provide a strong conceptual and empirical foundation for the present study on Structured Digital Learning Episodes (SDLE).

Across local and international literature, there is strong agreement that digital learning policies and frameworks promote improved instructional delivery and learner engagement. DepEd (2020, 2022), CHED (2020), and UNESCO (2023) all emphasize that technology-enhanced learning environments are most effective when instruction is intentionally structured. Similarly, OECD (2021) and Hodges et al. (2020) stress that digital tools alone are insufficient; rather, learning gains depend on carefully sequenced instructional design. These findings collectively support the present study's premise that SDLE must be systematically structured to improve learning outcomes in science.

A second converging theme is the effect of structured digital instruction on science achievement and conceptual understanding. Local studies such as Padios (2023), Abareta (2025), and Rayyanah (2025), together with foreign studies by Miller (2022), Garcia (2022), and Williams (2023), consistently show that learners exposed to well-designed digital learning materials demonstrate higher academic performance compared to those taught through traditional approaches. These studies suggest that structured multimedia content, simulations, and guided learning activities improve learners' understanding of abstract scientific concepts. This directly supports the SDLE intervention, which integrates organized content, guided activities, and multimedia resources to enhance Grade 9 science achievement.

A third and strongly recurring theme is the role of metacognition and self-regulated learning in improving academic performance. Local studies by Torres and Orleans (2021), Saguna and Prudente (2021), and Biscocho (2021), as well as foreign research by Veenman et al. (2017), Dignath and Veenman (2021), and Schraw et al. (2024), consistently demonstrate that learners with stronger metacognitive skills perform better academically. These studies highlight the importance of planning, monitoring, and evaluation as essential components of effective learning. They further emphasize that instructional interventions should explicitly embed metacognitive opportunities, which is a core feature of SDLE.

Closely related to this is evidence that technology-enhanced environments can foster metacognitive development. Studies by Azevedo and Gašević (2019), Panadero et al. (2022), Lee (2023), and Chen (2023) show that digital learning platforms that include reflection tasks, feedback mechanisms, and self-assessment activities significantly enhance learners' metacognitive awareness and regulation. These findings reinforce the design of SDLE, which integrates structured reflection and monitoring tasks to strengthen learners' metacognitive processes alongside content mastery.

Another important pattern across the literature is the identification of learning challenges in science education, particularly low achievement levels and difficulty in understanding abstract scientific concepts. Local evidence, such as PISA 2022 results (OECD, 2023) and Santos (2021), highlights persistent gaps in science literacy and unequal access to digital learning resources. These challenges justify the need for structured instructional interventions that are both accessible and pedagogically sound, such as SDLE.

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of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

Overall, the synthesis reveals a consistent international and local consensus: structured digital learning environments are more effective when they integrate (1) well-designed instructional content, (2) active learner engagement strategies, and (3) explicit metacognitive support. However, despite this strong body of evidence, most studies reviewed either focus separately on science achievement or metacognition or examine general digital learning tools rather than a structured, episode-based instructional model specifically designed for Grade 9 science learners. This gap justifies the present study, which seeks to develop and evaluate Structured Digital Learning Episodes as an integrated intervention to improve both science achievement and metacognitive skills within a unified instructional framework.

METHODS

Research Design

This study employed a Research and Development (R&D) design, a systematic process for developing, validating, implementing, and evaluating educational products to address identified instructional needs and improve learning outcomes (Creswell & Guetterman, 2024). Research and development is particularly appropriate for educational investigations that seek not only to generate knowledge but also to develop and refine instructional innovations grounded in empirical evidence. In the present study, the design was deemed suitable because it involved the development, validation, and pilot testing of Structured Digital Learning Episodes (SDLE) intended to enhance the science achievement and metacognition of Grade 9 learners.

The study was implemented through four interrelated phases: (1) Descriptive Survey, (2) Material Development, (3) Validation and Acceptability Assessment, and (4) Pilot Testing.

Phase 1 employed the Descriptive Survey Design. Descriptive survey research is used to systematically gather information regarding existing conditions, practices, perceptions, and concerns of a target population without manipulating variables (Creswell & Creswell, 2023). This phase was conducted to determine the extent of utilization of technology-assisted instructional strategies and the challenges encountered by Grade 9 Science teachers in their implementation. In addition to quantitative analysis, the responses pertaining to challenges encountered were subjected to thematic analysis, a qualitative analytic procedure used to identify, organize, and interpret recurring patterns or themes within a dataset (Braun & Clarke, 2022). Thematic analysis enabled the researcher to gain a deeper understanding of teachers' experiences, instructional concerns, and contextual realities that could not be fully explained through numerical data alone. The findings generated from both the survey results and thematic analysis served as the primary basis for the development of the SDLE.

Phase 2 utilized the Developmental Research Design. Developmental research focuses on the systematic design, development, refinement, and evaluation of instructional products intended to address identified educational needs (Creswell & Guetterman, 2024). This phase involved the development of the Structured Digital Learning Episodes using the findings from the descriptive survey, the themes that emerged from the qualitative analysis of teachers' challenges, relevant literature, established learning theories, and the Grade 9 Science curriculum competencies. Thematic analysis was likewise employed during this phase to synthesize the identified instructional needs and recurring concerns into meaningful design requirements. The resulting themes guided the selection of content, learning activities, multimedia resources, assessment tasks, and metacognitive components incorporated into the SDLE.

Phase 3 employed the Descriptive-Evaluative Design. Descriptive-evaluative research determines the quality, validity, usability, and acceptability of a product based on the judgments of qualified evaluators (McMillan, 2024). This design was appropriate because the developed SDLE required evaluation by Science teachers and subject-matter experts. The evaluators assessed the instructional material in terms of objectives, content, activities, usefulness, language and style, organization, presentation, evaluation, navigation, and overall acceptability. The results provided evidence regarding the suitability of the developed material for classroom implementation and served as a basis for refinement prior to pilot testing.

Phase 4 utilized the One-Group Pretest–Posttest Design. This pre-experimental design involves measuring a single group before and after exposure to an intervention to determine changes that may be associated with the treatment (McMillan, 2024). The design was considered appropriate because the study sought to determine the effectiveness of the SDLE in enhancing learners' science achievement and metacognition. Learners' baseline levels were established through the administration of the Science Achievement Test and Metacognition Questionnaire prior to implementation. Following exposure to the SDLE, the same instruments were administered to determine changes in performance and metacognitive awareness.

The integration of descriptive, developmental, evaluative, quantitative, and qualitative approaches enabled the study to comprehensively examine instructional needs, identify recurring implementation challenges, develop an evidence-based instructional intervention, establish its acceptability, and determine its effectiveness in improving the science achievement and metacognition of Grade 9 learners.

Population and Sampling

The respondents of the study consisted of 129 participants drawn from public secondary schools in District VI, Division of the City of Manila. These participants included science teachers, experts, Grade 9 learner-participants, and Grade 9 sections involved in the impact assessment of the Structured Digital Learning Episodes (SDLE). The population and sample distribution are presented in Table 1.

Table 1. *Sampling Methods and Techniques Employed in the Study*

Category	Population	Sample	Percentage	Sampling Method	Sampling Technique
Public Secondary Schools in the District VI, Division of Manila City	6	6	100.00%	Total Enume-ration	Total Enume-ration
Science Teachers	65	36	55.38%	Purpo-sive	Volun-tary Response
Science Experts	13	13	100.00%	Total Enume-ration	Total Enume-ration
Grade 9 Sections	8	3	37.50%	Random	Fishbowl
Learner-Participants	80	80	100.00%	Total Enume-ration	Total Enume-ration

The study employed different sampling methods and techniques depending on the nature and purpose of each respondent group. For the participating public secondary schools and experts, total enumeration sampling was utilized. Total enumeration involves including all members of a population when the size is manageable and when the participation of every member is deemed necessary to obtain comprehensive data (Creswell & Guetterman, 2024). Thus, all six public secondary schools in District VI and all thirteen identified expert-evaluators were included in the study.

For the science teachers, purposive sampling was employed using the voluntary response technique. Purposive sampling is a non-probability sampling method in which participants are selected based on specific characteristics relevant to the study (McMillan, 2024). Science teachers who were actively teaching Grade 9 Science and were willing to participate in the needs assessment phase were invited to respond to the survey. A total of 36 teachers participated, representing 55.38% of the teacher population.

For the pilot implementation phase, random sampling was used to select the participating Grade 9 sections. Specifically, the fishbowl technique was employed to ensure that each section had an equal chance of being selected. According to Creswell and Guetterman (2024), simple random sampling minimizes selection bias and increases the representativeness of the sample. Three out of the eight Grade 9 sections were randomly selected, representing 37.50% of the total number of sections.

The learner-participants consisted of all students enrolled in the three selected Grade 9 sections. Since the selected sections were used in their entirety during the pilot testing phase, total enumeration was again employed. Consequently, all 80 learners from the selected sections participated in the study and completed both the pretest and posttest measures on science achievement and metacognition.

The use of these sampling methods and techniques ensured that appropriate respondents were included in each phase of the study while providing adequate representation for needs assessment, material validation, acceptability evaluation, and pilot testing of the Structured Digital Learning Episodes.

Respondents of the Study

This section presents the demographic profile of the respondents who participated in the various phases of the study. The respondents consisted of science teachers who participated in the needs assessment phase, science experts who evaluated the acceptability of the Structured Digital Learning Episodes (SDLE), and Grade 9 learners who participated in the pilot testing phase. The profile variables included school affiliation, position, educational attainment, field of specialization, teaching experience, and use of technology in teaching. These characteristics were considered important in establishing the qualifications and representativeness of the respondents and in providing context for their responses and evaluations.

Table 2 presents the demographic profile of the 36 science teacher-respondents from the six public secondary schools in District VI, Division of the City of Manila. The table shows their distribution by school affiliation, position, educational attainment, field of specialization, teaching experience, and use of technology in teaching.

The teacher-respondents were equally represented across the six participating schools, with each school contributing six teachers or 16.67% of the total sample. This distribution ensured that the needs assessment reflected perspectives from all public secondary schools in the district. In terms of position, Teacher I constituted the largest group (41.67%), followed by Teacher III (33.33%) and Teacher II (25.00%), indicating that the respondents were primarily classroom practitioners actively involved in science instruction.

Table 2. *Demographic Profile of the Science Teachers*

Variable	Category	Freq.	Percentage
School Affiliation	Carlos P. Garcia HS	6	16.67%
	Elpidio Quirino HS	6	16.67%
	Emilio Aguinaldo HS	6	16.67%
	Eulogio Rodriguez VHS	6	16.67%
	Mariano Marcos HS	6	16.67%
	Victorino Mapa HS	6	16.67%
Positions	Teacher I	15	41.67%
	Teacher II	9	25.00%
	Teacher III	12	33.33%
Educational Attainment	Bachelor’s Degree	17	47.22%
	Master’s Units	11	30.56%
	Master’s Degree	8	22.22%
Field of Specialization	General Science	18	50.00%
	Biology	14	38.89%
	Chemistry	2	5.56%
	Physical Science	2	5.56%
Teaching Experience	less than 5 years	22	61.11%
	5-9 years	8	22.22%
	10-14 years	1	2.78%
	15-19 years	-	-
	20 years and above	5	13.89%
Technology Use in Teaching	Yes	36	100.00%
	No	0	0.00%

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Volume 2 Issue 8 (August 2026)

With respect to educational attainment, nearly half of the respondents (47.22%) held a bachelor's degree, while 30.56% had earned master's degree units and 22.22% had completed a master's degree. This profile suggests that a considerable number of teachers were pursuing or had attained graduate-level qualifications, which may contribute to their professional competence and awareness of contemporary instructional practices.

Regarding field of specialization, General Science accounted for the largest proportion (50.00%), followed by Biology (38.89%), while Chemistry and Physical Science each comprised 5.56% of the respondents. This distribution reflects the common assignment of science teachers to teach a broad range of science competencies across different learning areas. In terms of teaching experience, the majority (61.11%) had been teaching science for less than five years, while 22.22% had five to nine years of experience. Only 13.89% had twenty years or more of teaching experience. The findings indicate that the teacher-respondents were generally early-career educators who may be more receptive to technology-enhanced instructional innovations. Notably, all respondents (100.00%) reported using technology in their teaching, suggesting that technology-assisted instruction had become an established component of science education in the participating schools. Consequently, the respondents were well-positioned to identify instructional needs and challenges relevant to the development of the SDLE.

Table 3 presents the demographic profile of the 13 science experts who assessed the acceptability of the developed SDLE. The table includes their school affiliation, position, educational attainment, field of specialization, and years of service.

The experts were drawn from all six participating schools, with the largest representations coming from Mariano Marcos High School and Victorino Mapa High School, each contributing 23.08% of the experts. In terms of position, the majority were Master Teachers (69.23%), while the remaining respondents were Head Teachers or Teachers-in-Charge (30.77%). Their roles in instructional supervision, curriculum implementation, and teacher mentoring provided them with the expertise necessary to evaluate the quality and suitability of the instructional materials.

Table 3. *Demographic Profile of the Science Experts*

Variable	Category	Freq.	Percentage
School Affiliation	Carlos P. Garcia HS	2	15.38%
	Elpidio Quirino HS	2	15.38%
	Emilio Aguinaldo IS	1	7.69%
	Eulogio Rodriguez VHS	2	15.38%
	Mariano Marcos HS	3	23.08%
	Victorino Mapa HS	3	23.08%
Positions	Master Teachers	9	69.23%
	Head Teachers or TIC	4	30.77%
Educational Attainment	Master's Units	2	15.38%
	Master's Degree	9	69.23%
	Doctorate Degree	2	15.38%
Field of Specialization	General Science	6	46.15%
	Biology	5	38.46%
	Physical Science	2	15.38%
Years in Service	5 - 9 years	1	7.69%
	10 - 14 years	3	23.08%
	20 years and above	9	69.23%

The educational qualifications of the experts further demonstrated their competence to assess the SDLE. Most had completed a master's degree (69.23%), while 15.38% possessed doctoral degrees and another 15.38% had earned graduate units. Their academic preparation indicates substantial professional knowledge and experience in educational practice. In terms of specialization, General Science accounted for the largest share (46.15%), followed by Biology (38.46%) and Physical Science (15.38%). This distribution ensured that the instructional materials were evaluated by experts with relevant disciplinary backgrounds. Moreover, the majority of the experts (69.23%) had rendered twenty years or more of service, while 23.08% had served for 10 to 14 years. Their extensive experience strengthened the credibility of their judgments regarding the acceptability and quality of the SDLE.

The learner-participants consisted of 80 Grade 9 students enrolled in the three sections selected through the fishbowl technique from among the eight Grade 9 sections in the pilot-testing school. All learners in the selected sections participated in the study's implementation phase. Since the primary objective of their participation was to determine the effectiveness of the SDLE in enhancing science achievement and metacognition, individual demographic characteristics were not included as profile variables. Instead, their pretest and posttest performance served as the basis for evaluating the effectiveness of the instructional materials developed.

Research Instrument

Four research instruments were utilized in the conduct of the study: (1) the Extent of Utilization and Challenges Encountered Questionnaire, (2) the Structured Digital Learning Episodes (SDLE) Acceptability Questionnaire, (3) the Science Achievement Test, and (4) the Metacognition Questionnaire. These instruments were developed, validated, pilot-tested, and administered to gather data necessary to address the research problems and evaluate the effectiveness of the Structured Digital Learning Episodes.

Extent of Utilization and Challenges Encountered Questionnaire

A researcher-developed questionnaire was used to determine the extent of utilization of technology-assisted instructional strategies and the challenges encountered by Science teachers in implementing such approaches. The instrument consisted of two parts. Part I gathered demographic information about the respondents, including school affiliation, position, educational attainment, field of specialization, years of teaching experience, and technology use in instruction. Part II contained statements measuring the extent of utilization of structured digital learning strategies and the challenges encountered in their implementation.

The questionnaire employed a five-point Likert scale. For utilization, the response categories ranged from Not Utilized (1) to Highly Utilized (5). For challenges encountered, responses ranged from Not a Challenge (1) to Very Challenging (5).

To establish content validity, the instrument was evaluated by experts in Science education and educational research. Revisions were made based on their recommendations. The instrument was subsequently pilot tested among 15 Science teachers from Carlos P. Garcia High School who were not included in the actual study. Reliability analysis yielded a Cronbach's alpha coefficient of 0.972, indicating excellent internal consistency. The validated instrument was administered to Science teachers from the selected public secondary schools in District VI, Division of the City of Manila.

The instrument was pilot tested among teachers not included in the study. Reliability analysis using Cronbach's alpha yielded a coefficient of 0.965, indicating excellent internal consistency.

Structured Digital Learning Episodes Acceptability Questionnaire

The acceptability of the developed Structured Digital Learning Episodes was assessed using a researcher-developed evaluation questionnaire. The instrument consisted of three parts. Part I obtained the respondents' demographic profiles. Part II contained 40 evaluative statements distributed across ten dimensions: Objectives, Content, Activities, Usefulness, Language and Style, Organization, Presentation, Evaluation, Navigation, and Overall Acceptability. Part III provided space for comments, observations, and recommendations regarding the developed instructional materials.

Responses were rated using a five-point Likert scale ranging from Not Acceptable (1) to Highly Acceptable (5). The instrument was designed to determine the extent to which the SDLE met established criteria for instructional quality and usability.

The questionnaire underwent expert validation involving Science supervisors, master teachers, head teachers, and research specialists. Their suggestions were incorporated to improve the clarity, relevance, and adequacy of the indicators. Prior to its actual administration, the instrument was pilot tested with Science teachers who were not included in the study to establish reliability and item consistency. The finalized instrument was administered to Science teachers and expert evaluators to assess the developed SDLE modules.

Science Achievement Test

The Science Achievement Test was developed by the researcher to measure learners' mastery of the Grade 9 Science competencies covered by the Structured Digital Learning Episodes. The test consisted of 30 multiple-choice items covering the Fourth Quarter topics in Science 9, including projectile motion, momentum, impulse, collisions, work, energy, heat engines, geothermal energy, and electric power transmission.

A table of specifications was prepared to ensure alignment between the learning competencies, cognitive objectives, and test items. The test underwent expert validation by Science educators and content specialists, who examined the items for content accuracy, curriculum alignment, clarity, and appropriateness for Grade 9 learners.

The validated test was pilot-tested with 40 Grade 9 learners from Carlos P. Garcia High School who were not included in the actual study. Item analysis was conducted to determine the quality of the test items. The test obtained KR-20 and KR-21 coefficients of 0.86 and 0.84, respectively, indicating high reliability. The average difficulty index of 0.58 indicated that the test was of moderate difficulty, while the average discrimination index of 0.42 indicated very good discriminating power.

The Science Achievement Test served as both the pretest and posttest for the learner-participants, administered before and after exposure to the Structured Digital Learning Episodes.

Metacognition Questionnaire

The Metacognition Questionnaire was utilized to measure learners' metacognitive awareness and regulation in learning Science. The instrument was adapted from the metacognitive framework of Schraw and Dennison and consisted of 40 statements organized into two major domains: Knowledge of Cognition and Regulation of Cognition.

The Knowledge of Cognition domain included Declarative Knowledge, Procedural Knowledge, and Conditional Knowledge, while the Regulation of Cognition domain consisted of Planning, Monitoring, Information Management Strategies, Debugging Strategies, and Evaluation. Each dimension was represented by five statements.

The instrument employed a five-point Likert scale ranging from Never True (1) to Always True (5). Higher scores indicated greater metacognitive awareness and self-regulation.

The questionnaire underwent expert validation to determine the relevance, clarity, and appropriateness of the items. After revision, it was pilot tested among 40 Grade 9 learners from Carlos P. Garcia High School who were not included in the actual study. Reliability analysis produced a Cronbach's alpha coefficient of 0.94, indicating excellent internal consistency.

The Metacognition Questionnaire was administered as a pretest and posttest measure to determine changes in learners' metacognitive awareness following exposure to the Structured Digital Learning Episodes.

Collectively, these instruments provided the quantitative and qualitative data necessary to determine the utilization of technology-assisted instructional strategies, identify implementation challenges, evaluate the acceptability of the developed SDLE modules, and assess their effectiveness in improving learners' science achievement and metacognition.

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of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

Data Gathering Procedures

Data gathering followed four major phases: needs assessment, development of the Structured Digital Learning Episodes (SDLE), validation and acceptability assessment, and impact assessment. The procedures were carried out systematically to ensure the validity, reliability, and credibility of the findings.

A. Preliminary Activities

1. ***Securing of Permissions*.** Prior to conducting the study, the researcher sought approval from the Schools Division Superintendent of the Division of the City of Manila and the school heads of the participating schools. Formal letters requesting permission to conduct the study were submitted to the concerned offices. See Appendices E-G for the documentation.
2. ***Validation and Pilot Testing of Instruments.*** The researcher-developed instruments were submitted to experts in Science education, educational technology, and research for content validation. Revisions were made based on the validators' recommendations. Thereafter, the survey questionnaires and achievement test were pilot tested with respondents not included in the actual study to establish reliability and determine the instruments' psychometric properties.
3. ***Orientation of Participants*.** Before data collection, the researcher conducted an orientation for the participants on the study's objectives, data collection procedures, ethical considerations, and their rights as research participants. Informed consent was obtained prior to participation.

B. Phase 1: Descriptive Survey (Needs Assessment)

1. ***Administration of the Needs Assessment Questionnaire*.** During the first quarter of School Year 2025–2026, the Extent of Utilization and Challenges Encountered Questionnaire was administered to the selected Science teachers from the six public secondary schools in District VI, Division of the City of Manila.
2. ***Retrieval and Processing of Responses*.** Upon completion, the questionnaires were retrieved, checked for completeness, encoded, and tabulated. The data were analyzed to determine the extent of utilization of technology-assisted instructional strategies and the challenges encountered by Science teachers.
3. ***Identification of Developmental Inputs*.** The findings from the needs assessment served as the basis for identifying the instructional needs, design considerations, and content requirements for developing the Structured Digital Learning Episodes.

C. Phase 2: Development of the Structured Digital Learning Episodes

1. ***Design and Development of the SDLE*.** Guided by the results of the needs assessment, relevant literature, learning theories, and the Grade 9 Science curriculum (Appendix H), the researcher developed the Structured Digital Learning Episodes. Each module was designed to include learning objectives, multimedia-based instructional content, guided learning activities, formative assessments, and reflection tasks.
2. ***Technical Preparation of the Modules*.** The developed modules were formatted and organized into digital learning episodes that could be accessed through digital devices and utilized in technology-assisted learning environments.

D. Phase 3: Validation and Acceptability Assessment

1. ***Expert Validation of the SDLE*.** The developed modules were submitted to Science experts, master teachers, and head teachers for evaluation. The validators examined the modules for instructional quality, curriculum alignment, content accuracy, organization, and suitability for Grade 9 learners. Certificates of validation issued by the validators are compiled in Appendix I.

2. ***Administration of the Acceptability Questionnaire*.** The SDLE Acceptability Questionnaire was administered to the teacher-evaluators and expert-validators to assess the modules in terms of objectives, content, activities, usefulness, language and style, organization, presentation, evaluation, navigation, and overall acceptability.
3. ***Revision of the SDLE*.** The comments, suggestions, and evaluation results from the validators were analyzed and used as the basis for revising and improving the modules. Necessary modifications were incorporated to produce the final version of the Structured Digital Learning Episodes.

E. Phase 4: Pilot Testing of the SDLE

1. ***Selection of Learner-Participants*.** Three Grade 9 sections from Carlos P. Garcia High School were selected through the fishbowl method. One section was used to pilot test the revised SDLE. All learners enrolled in the selected section participated in the implementation phase.
2. ***Administration of the Pretest*.** Prior to the implementation of the SDLE, the Science Achievement Test and the Metacognition Questionnaire were administered to the learner-participants to determine their baseline levels of science achievement and metacognition.
3. ***Implementation of the SDLE*.** The revised and validated Structured Digital Learning Episodes were implemented during the Fourth Quarter of School Year 2025–2026. The modules were integrated into the regular Science instruction for participating learners during the intervention period.
4. ***Administration of the Posttest*.** Upon completion of the implementation, the same Science Achievement Test and Metacognition Questionnaire were administered to determine changes in learners' science achievement and metacognitive awareness after exposure to the SDLE.
5. ***Collection and Organization of Data*.** All accomplished instruments were retrieved, checked, coded, and organized for statistical treatment. The pretest and posttest results were tabulated and prepared for analysis.
6. ***Statistical Analysis and Interpretation*.** The collected data were analyzed using appropriate descriptive and inferential statistical tools to address the research questions and test the study's hypotheses. The findings served as the basis for determining the effectiveness of the Structured Digital Learning Episodes in enhancing learners' science achievement and metacognition.
7. ***Observance of Research Ethics*.** Throughout the study, ethical standards were strictly observed. Participation was voluntary; informed consent was obtained; the confidentiality of responses was maintained; and all data were stored and reported responsibly and exclusively for research purposes.

Statistical Treatment of Data

The data gathered in this study were organized, tabulated, analyzed, and interpreted using appropriate descriptive and inferential statistical tools. The statistical techniques employed were selected based on the nature of the data collected and the specific sub-problems addressed in the study.

***Weighted Mean*.** The weighted mean was used to determine the extent of utilization of technology-assisted instructional strategies, the degree of challenges encountered by science teachers, the acceptability of the Structured Digital Learning Episodes (SDLE), and the level of learners' metacognition before and after the intervention. Specifically, this statistical tool was utilized in Sub-Problems Nos. 1, 2, 4, and 5.

***Rank*.** Rank was used to determine the relative position of each indicator based on its computed weighted mean. This statistical tool enabled the identification of the most and least utilized instructional strategies, the most and least challenging concerns encountered by teachers, and the highest- and lowest-rated indicators of acceptability and metacognition. Rank was employed in Sub-Problems Nos. 1, 2, 4, and

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of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

5. Indicators were arranged in descending order, with the highest mean assigned Rank 1 (McMillan, 2024).

***Grand Mean*.** The grand mean was used to determine the overall level of utilization, challenges encountered, acceptability, and metacognition by averaging the weighted means of all indicators within a particular dimension. This statistical tool was utilized in Sub-Problems Nos. 1, 2, 4, and 5.

***Frequency*.** Frequency was used to determine the number of respondents in each category and to describe the distribution of learners by their science achievement and metacognitive levels during the pilot-testing phase. This statistical tool was employed in Sub-Problem No. 5.

***Percentage*.** Percentages were used to describe the proportion of respondents in each category and to present the distribution of learners by achievement and metacognition levels. This statistical tool was likewise employed in Sub-Problem No. 5.

***Mean*.** The arithmetic mean was used to determine the average scores of learners in the Science Achievement Test and Metacognition Questionnaire during the pretest and posttest administrations. This statistical tool was employed in Sub-Problem No. 5.

***Standard Deviation*.** Standard deviation was used to measure the variability or dispersion of learners' scores around the mean. This measure provided information regarding the consistency of learners' performance in science achievement and metacognition. It was employed in Sub-Problem No. 5.

***Shapiro–Wilk* Test.** The Shapiro–Wilk Test was used to assess whether the pretest and posttest scores for science achievement and metacognition were normally distributed. The results of this test served as the basis for selecting the appropriate inferential statistical procedure. This statistical tool was utilized in Sub-Problem No. 5. The Shapiro–Wilk statistic is expressed as:

$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n}(x_i - \overline{x})^2}$ where W is the test statistic, a_i are constants derived from expected normal order statistics, $x_{(i)}$ are ordered sample values, x_i are individual observations, and $\overline{x}$ is the sample mean (Shapiro & Wilk, 1965). A p-value greater than .05 indicated that the data were normally distributed, whereas a p-value less than or equal to .05 indicated non-normal distribution.

***Wilcoxon Signed-Rank Test*.** The Wilcoxon Signed-Rank Test was employed as the nonparametric alternative to the Dependent Samples t-test when the assumption of normality was violated. This test determined whether significant differences existed between the pretest and posttest scores in science achievement and metacognition. It was utilized in Sub-Problem No. 5. The test statistic is represented by:

$$T = min$$

where T is the Wilcoxon test statistic, T^+ is the sum of positive ranks, and T^- is the sum of negative ranks (Field, 2024). The null hypothesis was rejected when the computed probability value was less than or equal to 0.05.

RESULTS AND DISCUSSION

Sub-problem No. 1. What is the extent of utilization of Structured Digital Learning Episodes for Grade 9 Science learners in the District VI, Division of the City of Manila?

Table 4 presents the extent of utilization of Structured Digital Learning Episodes (SDLE) in teaching Grade 9 Science as perceived by the teacher-respondents. The overall result yielded a grand mean of 3.52, interpreted as *"Utilized," indicating that science teachers generally incorporate technology-assisted instructional strategies in their practice*. This finding suggests that digital learning approaches have become a regular component of science instruction within the participating schools, although their integration may vary across specific instructional functions.

IJERIP
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Volume 2 Issue 8 (August 2026)

Table 4. *Extent of Utilization of Structured Digital Learning Episodes in Teaching Grade 9 Science*

	Indicators	Weighted Mean	Interpretation	Rank
1.	I regularly use technology-assisted instructional strategies in delivering Science lessons.	**3.39**	Moderately Utilized	9
2.	Technology-assisted instructional strategies are integrated into my weekly lesson plans.	**3.22**	Moderately Utilized	10
3.	These strategies are used to introduce new science concepts.	**3.69**	Utilized	1
4.	These strategies are used for reinforcement and remediation activities.	**3.53**	Utilized	5.5
5.	These strategies are aligned with Science MELCs.	**3.58**	Utilized	4
6.	These strategies support learner engagement in Science lessons.	**3.61**	Utilized	3
7.	These strategies enhance students' understanding of abstract science concepts.	**3.50**	Utilized	7
8.	These strategies promote independent and self-paced learning.	**3.47**	Utilized	8
9.	These strategies are used as part of assessment activities.	**3.67**	Utilized	2
10.	I am confident in using technology-assisted instructional strategies in my teaching.	**3.53**	Utilized	5.5
	Grand Mean	**3.52**	**Utilized**	

Among the indicators, the statement *"These strategies are used to introduce new science concepts"* obtained the highest weighted mean (WM = 3.69, Rank 1), followed by *"These strategies are used as part of assessment activities"* (WM = 3.67, Rank 2) and *"These strategies support learner engagement in Science lessons"* (WM = 3.61, Rank 3). These findings indicate that teachers primarily use technology-assisted strategies during lesson introductions, learner engagement, and assessment. The high use of digital tools to present new concepts may be attributed to their ability to provide visual, interactive, and multimedia representations of scientific phenomena, making complex concepts easier for learners to understand. Likewise, the use of digital tools in assessment activities suggests that teachers recognize the value of technology in providing immediate feedback and monitoring learner progress.

In contrast, the indicators *"Technology-assisted instructional strategies are integrated into my weekly lesson plans"* (WM = 3.22, Rank 10) and *"I regularly use technology-assisted instructional strategies in delivering Science lessons"* (WM = 3.39, Rank 9) obtained the lowest ratings. Although both indicators still fall within the range of utilization, the findings imply that technology-assisted instruction has not yet been fully institutionalized as a routine component of weekly instructional planning. This suggests that while teachers recognize the instructional benefits of digital learning tools, their application may still depend on the availability of resources, time, infrastructure, and instructional requirements.

The results indicate that technology-assisted instructional strategies are generally utilized in Grade 9 Science instruction; however, their implementation appears to be more concentrated on specific instructional purposes rather than systematically embedded across all aspects of teaching and learning. The findings suggest that teachers are more likely to employ digital learning approaches when introducing lessons, facilitating learner engagement, and conducting assessments than when planning and delivering instruction on a consistent basis.

The present findings support the Department of Education's (2022) policy directions through the Digital Rise Program, which advocates integrating digital technologies to improve instructional delivery and learner engagement. The results likewise affirm the observations of Sasota et al. (2021) that science teachers increasingly utilize technology in instruction when they possess the necessary skills, willingness, and access to digital resources. The relatively high ratings for learner engagement and assessment also corroborate the findings of Bond et al. (2021) and Sung et al. (2019), who reported that technology-supported learning environments can enhance student participation and academic performance when integrated into meaningful learning activities.

Furthermore, the findings are consistent with García-Martínez et al. (2023), who concluded that digital resources are particularly effective in supporting science learning by facilitating visualization and conceptual understanding. This may explain why respondents reported frequent utilization of technology-assisted strategies in introducing new science concepts and enhancing learners' understanding of abstract scientific ideas. Similarly, the findings align with **Padios (2023)**, whose study demonstrated that technology-enhanced science learning experiences contribute positively to learners' achievement and engagement.

However, the comparatively lower ratings on regular classroom use and integration into weekly lesson plans appear to support the observations of Santos (2021) and Trust and Whalen (2020) that limitations in technological infrastructure, access to digital resources, and implementation challenges may constrain the consistent use of technology-assisted instruction. These findings suggest that despite teachers' positive disposition toward digital learning, practical constraints may still hinder its full integration into everyday classroom practice.

Overall, the findings reveal that Structured Digital Learning Episodes and other technology-assisted instructional strategies are generally utilized in Grade 9 Science instruction, particularly for introducing lessons, engaging learners, and conducting assessments. Nevertheless, the lower ratings obtained for regular utilization and lesson planning integration indicate opportunities for strengthening the systematic and sustained implementation of digital learning approaches in science education. These findings underscore the need for instructional interventions such as the Structured Digital Learning Episodes, which are designed to provide teachers with organized, curriculum-aligned, and readily implementable digital learning resources to facilitate more consistent technology integration in science instruction.

Sub-problem No. 2. What are the challenges encountered by science teachers in using Structured Digital Learning Episode (SDLE)?

Table 5 presents the challenges encountered by Science teachers when using Structured Digital Learning Episodes (SDLE) to teach Grade 9 Science. The overall assessment yielded a mean of 4.08, interpreted as *Challenging*, indicating that teachers experience considerable difficulties in implementing SDLE despite recognizing its instructional value.

Table 5. *Challenges Encountered by Teachers in Using* Structured Digital Learning Episodes *in Teaching Grade 9 Science*

	Challenges Encountered	Mean	Interpretation	Rank
1.	Limited access to stable internet affects the implementation of technology-assisted instructional strategies.	**4.25**	Very Challenging	2.5
2.	Lack of appropriate devices (desktop, laptop, tablet, cellphone, etc.) hinders effective use of technology-assisted instructional strategies.	**4.31**	Very Challenging	1
3.	Limited access to digital tools and resources affects the effective use of technology-assisted instructional	**4.22**	Very Challenging	4.5

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

	strategies.			
4.	Developing technology-assisted instructional strategies requires too much preparation time.	**3.92**	Challenging	10
5.	I need more training in designing technology-assisted instructional strategies.	**4.03**	Challenging	9
6.	I find it difficult to design these strategies for complex science topics.	**4.25**	Very Challenging	2.5
7.	Some learners struggle to follow structured technology-assisted learning activities independently.	**4.06**	Challenging	8
8.	Learners have varying levels of digital literacy.	**4.08**	Challenging	7
9.	Learners' lack of motivation affects the effectiveness of these strategies.	**3.72**	Challenging	12
10.	There is limited institutional support for implementing technology-assisted instructional strategies.	**4.22**	Very Challenging	4.5
11.	Monitoring learner progress using these strategies is challenging.	**4.14**	Challenging	6
12.	There is a lack of standardized templates or guidelines for implementing these strategies.	**3.72**	Challenging	11
	Overall Assessment	**4.08**	**Challenging**	

Among the identified challenges, *lack of appropriate devices such as desktops, laptops, tablets, and cellular phones* obtained the highest mean of 4.31 and was interpreted as *Very Challenging*. This was followed by *limited access to stable internet connectivity and difficulty in designing SDLE for complex science topics*, both with a mean of 4.25, likewise interpreted as *Very Challenging*. Other challenges rated as *Very Challenging* included *limited access to digital tools and resources and limited institutional support for implementation*, both of which obtained a mean of 4.22. On the other hand, *learners' lack of motivation affects the effectiveness of these strategies, and lack of standardized templates or guidelines for implementation received the lowest mean* of 3.72, although both were still interpreted as *Challenging*.

The findings indicate that the most pressing concerns in SDLE implementation are primarily related to technological infrastructure, the availability of learning resources, teachers' capability to design digital learning experiences, and institutional support systems. The prominence of device availability and internet connectivity as the top-ranked challenges suggests that access to technology remains a critical prerequisite for successful implementation of structured digital learning. Even when teachers are willing to integrate digital innovations into instruction, inadequate technological resources may limit the consistent and effective use of SDLE. Furthermore, the difficulty in designing SDLE for complex science concepts highlights the need for specialized training and instructional support to help teachers translate abstract scientific ideas into meaningful digital learning experiences.

These findings are consistent with the work of Sasota et al. (2021), who reported that the successful integration of educational technology depends not only on teachers' willingness but also on the availability of technological tools and institutional support. Their Will–Skill–Tool Model emphasizes that effective technology integration requires a balance among teachers' motivation, competence, and access to resources. Similarly, Trust and Whalen (2020) found that teachers frequently encounter difficulties in implementing technology-supported instruction due to inadequate infrastructure, limited professional preparation, and insufficient access to appropriate digital resources. The results likewise support the observations of García-Martínez et al. (2023) that while digital resources have considerable potential to improve science learning, challenges related to access, teacher readiness, and implementation support often hinder their optimal use.

To gain deeper insights into how teachers address these implementation challenges, qualitative responses were analyzed thematically (see Appendix J). The analysis generated the overarching theme Adaptive Strategies in Addressing SDLE Implementation Challenges, which encompasses three categories: Instructional Practices, Teacher Capacity Development, and Resources and Institutional Support, as shown in Table 6.

Table 6. *Thematic Coding of Teachers' Strategies in Addressing SDLE Implementation Challenges*

Themes	Category	Codes
Adaptive Strategies in Addressing SDLE Implementation Challenges	Instructional Practices	• Use of varied teaching strategies • Use of interactive and digital tools • Use of digital platforms (LMS/GC) • Use of simulations and digital experiments • Collaborative and active learning strategies • Assessment and monitoring strategies
	Teacher Capacity Development	• Need for teacher training Engagement in professional development
	Resources and Institutional Support	• Lack of resources and materials • Need for institutional/stakeholder support

The first category, *Instructional Practices,* highlights teachers' efforts to adapt instruction through varied teaching strategies, interactive digital tools, learning management systems, simulations, digital experiments, collaborative learning activities, and assessment-monitoring mechanisms. Teachers reported maximizing available technologies and modifying instructional approaches to sustain learner engagement and ensure continuity of learning despite existing constraints. These responses demonstrate that teachers actively employ flexible and innovative practices to overcome barriers associated with SDLE implementation.

The second category, *Teacher Capacity Development,* emphasizes the need for continuous professional growth. Teachers acknowledged the importance of attending training programs, participating in professional development activities, and enhancing their competencies in designing and implementing structured digital learning experiences. The emergence of this category reinforces the quantitative finding that teachers experience challenges in developing SDLE, particularly for complex science topics. It further suggests that sustained capacity-building initiatives are necessary to strengthen teachers' digital pedagogical skills.

The third category, *Resources and Institutional Support*, underscores the importance of adequate materials, technological infrastructure, and stakeholder support. Teachers emphasized the need for sufficient equipment, improved facilities, learning resources, and stronger institutional backing to facilitate effective implementation. This category aligns with the quantitative results showing that limited resources and institutional support were among the most significant challenges encountered.

Taken together, the qualitative findings reveal that while teachers employ adaptive and resourceful strategies to address implementation barriers, the success of SDLE remains strongly influenced by external support mechanisms. Teachers can modify instructional practices and pursue professional growth; however, the sustainability and effectiveness of SDLE implementation require adequate technological resources, structured professional development opportunities, and strong institutional commitment. These findings suggest that efforts to promote SDLE should focus not only on developing instructional materials but also on strengthening the technological, professional, and organizational conditions necessary for their successful implementation.

The thematic findings are supported by Dignath and Veenman (2021), who emphasized that effective instructional innovation requires both teacher competence and systematic support structures.

Likewise, Saguna and Prudente (2023) highlighted that successful science classroom innovations are sustained through continuous teacher development, collaborative support systems, and institutional commitment. Furthermore, Bond et al. (2021) noted that the effectiveness of digital learning initiatives is significantly enhanced when schools provide adequate resources, professional support, and implementation frameworks that enable teachers to adapt innovations to their local contexts. These studies reinforce the present finding that addressing SDLE implementation challenges requires a comprehensive approach involving instructional adaptation, teacher empowerment, and institutional support.

Sub-problem No. 3. Based on the findings, what SDLE modules may be proposed?

The study's findings served as the foundation for developing the proposed Structured Digital Learning Episodes (SDLE) for Grade 9 Science. Specifically, the results from Sub-Problems 1 and 2 guided the selection of instructional approaches, learning activities, digital resources, and support mechanisms for the SDLE modules.

Findings under Sub-Problem 1 revealed that science teachers generally used technology-assisted instructional strategies in teaching Science, particularly interactive digital tools, simulations, learning management systems, gamification, collaborative activities, and formative assessment techniques. Teachers also reported employing varied instructional approaches such as flipped classroom strategies, digital repositories, and simulation-based learning to promote learner engagement and understanding of scientific concepts. These findings indicate that teachers recognize the value of interactive and technology-enhanced learning experiences in facilitating science instruction.

However, findings under Sub-Problem 2 showed that the utilization of SDLE is constrained by several challenges. Teachers identified the need for continuous professional development, adequate technological resources, reliable internet connectivity, digital devices, structured implementation guides, and institutional support. Likewise, the thematic analysis of respondents' recommendations highlighted the importance of teacher training and professional development, provision of resources and infrastructure, and system and instructional support mechanisms to strengthen SDLE implementation.

Considering these findings, a Structured Digital Learning Episodes (SDLE) package for selected Grade 9 Fourth Quarter Science topics was developed. The instructional package consists of SDLE modules, instructional videos, simulation-based learning activities, assessment tools, reflection activities, and implementation guides designed to support technology-assisted and learner-centered instruction.

The proposed SDLE adopts the Science Metacognition Through Structured Digital Learning Episodes Learning Framework and follows the 7E learning sequence to provide a structured learning pathway. Each lesson includes clearly defined learning objectives, introductory activities, concept-development tasks, guided investigations, formative assessments, reflection activities, and enrichment tasks. This structured organization directly responds to teachers' recommendations for standardized templates and clear implementation guidelines.

To address the teachers' preference for interactive and engaging instructional strategies, simulation-based activities were incorporated throughout the modules. For example, lessons on the Law of Conservation of Momentum use digital collision simulations that allow learners to manipulate variables, predict outcomes, analyze changes in momentum, and verify scientific principles through virtual experimentation. Learners investigate elastic and inelastic collisions, compare momentum values before and after interactions, and apply the MOMENTUM problem-solving framework to authentic situations. These activities provide opportunities for inquiry-based and experiential learning while overcoming the limitations of laboratory resources.

Similarly, lessons on the Conservation of Mechanical Energy employ interactive pendulum simulations that enable learners to examine the relationship between kinetic and potential energy under varying conditions. Through guided investigations, learners collect and analyze data, evaluate energy transformations, and explore the effects of friction and efficiency in real-world systems. These simulation-

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International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

based activities were included in response to teachers' reported use of digital experiments and simulations as effective strategies for promoting learner engagement and conceptual understanding.

In addition to simulations, a series of SDLE instructional videos was developed to support self-paced and flexible learning (Appendix K). These videos present scientific concepts through contextualized, real-life situations that make abstract principles more meaningful and accessible to learners. For instance, the video *"From Height to Haste: How Roller Coasters Defy Gravity" illustrates the Law of Conservation of Mechanical Energy through a roller coaster's motion*, allowing learners to visualize the continuous transformation between potential and kinetic energy. Likewise, *From Impact to Inertia: The Power of Momentum Conservation* uses familiar examples such as vehicles, projectiles, and bumper-car collisions to explain the Law of Conservation of Linear Momentum. These videos address teachers' recommendations for accessible digital learning resources while supporting learners who may require additional instructional reinforcement outside the classroom.

The SDLE package also includes contextualized video lessons such as *Earth's Engine: Tapping into the Power of Geothermal Energy* and *Powering the Archipelago: The Heavyweights of Philippine Geothermal Energy*. These materials connect scientific concepts to local and national contexts by highlighting the Philippines' geothermal energy resources and energy production systems. Such contextualization supports meaningful learning and aligns with teachers' recommendations for instructional materials that enhance learner engagement and relevance.

To promote learner reflection and metacognitive development, each lesson integrates self-assessment tasks, reflection prompts, learning journals, and error-analysis activities. These components encourage learners to monitor their understanding, evaluate their performance, and identify areas for improvement. Furthermore, formative assessment tools, performance tasks, and analytic rubrics are embedded throughout the modules to provide continuous feedback and support learner progress.

Overall, the proposed Structured Digital Learning Episodes were developed in direct response to the study's findings. The integration of simulations, instructional videos, interactive activities, structured lesson guides, formative assessments, and metacognitive tasks reflects the instructional strategies currently utilized by teachers while addressing the challenges and support needs identified in the study. Consequently, the proposed SDLE provides a comprehensive, accessible, and technology-enhanced instructional intervention designed to improve learner engagement, conceptual understanding, and the effective utilization of digital learning approaches in Grade 9 Science.

Likewise, the quantitative findings presented in the preceding sections revealed that while science teachers generally utilize technology-assisted instructional strategies in their classes, several challenges continue to hinder the optimal implementation of Structured Digital Learning Episodes (SDLE). Among the challenges identified were limitations in teacher preparation, availability of technological resources, internet connectivity, and the need for structured implementation support. To gain deeper insights into how these challenges might be addressed, the respondents were asked to provide recommendations to improve SDLE utilization in Grade 9 Science. Their responses were analyzed using thematic coding, yielding the themes and categories presented in Table 7.

Table 7**.** *Thematic Coding of Recommended Support Systems for Effective SDLE Implementation*

Themes	Category	Codes
Strengthening Support Systems for Effective SDLE Implementation	Teacher Training and Professional Development	• Need for digital literacy development • Need for practical/hands-on training • Need for continuous teacher training • Training for both teachers and learners
	Provision of Resources and Infrastructure	• Provision of devices and internet
	System and Instructional Support	• Provision of digital tools/software

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of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

Mechanisms	• Provision of structured templates • Need for institutional/government support

Table 7 shows that the recommendations of the respondents converged into one overarching theme, Strengthening Support Systems for Effective SDLE Implementation, which encompasses three categories: Teacher Training and Professional Development, Provision of Resources and Infrastructure, and System and Instructional Support Mechanisms. These categories collectively reflect the support structures that science teachers perceive as necessary for the successful implementation of SDLE.

The theme highlights respondents' recognition that the effectiveness of SDLE depends not only on the availability of technology but also on adequate support systems to sustain its implementation. While the quantitative findings demonstrated teachers' willingness to integrate technology-assisted instructional strategies, the qualitative responses revealed that successful implementation requires continuous capacity building, sufficient resources, and clear implementation frameworks.

A dominant recommendation among respondents was the need for continuous, practical professional development opportunities. Science teachers emphasized that effective SDLE implementation requires not only familiarity with digital tools but also sufficient pedagogical and technological competencies to maximize their instructional value.

One respondent stated: *"More trainings, not just during Inset or LAC, training with hands-on activities."* Another respondent shared: *"Provide professional development of the utilization of SDLE for teachers."* Similarly, another emphasized: *"Teachers should be trained well on SDLE and provide gadgets for both teachers and learners."*

These responses suggest that teachers perceive professional development as a critical prerequisite for effective SDLE utilization. The findings support the quantitative results indicating that inadequate knowledge and training remain among the barriers to implementation. Consequently, teachers advocate for continuous and hands-on training programs that can strengthen their confidence and competence in designing and facilitating technology-enhanced learning experiences.

Another significant category that emerged from the analysis pertains to the provision of adequate technological resources and infrastructure. Respondents highlighted the necessity of stable internet connectivity, digital devices, and information technology resources to facilitate effective SDLE implementation.

One respondent noted: *"access to stable internet, computer, laptop, and other IT equipment for class."* Another stated: *"provide gadgets and strong internet connectivity for proper utilization."* Likewise, another respondent emphasized: *"government should provide school internet and reliable devices."*

These responses reinforce the quantitative findings that identified lack of resources and technological limitations as major implementation challenges. The participants recognized that regardless of the effectiveness of instructional strategies, SDLE implementation may remain constrained if teachers and learners do not have equitable access to the necessary technological infrastructure.

The respondents likewise underscored the need for structured instructional and organizational support systems to ensure consistency in SDLE implementation. Recommendations included the provision of standardized templates, ready-made instructional materials, appropriate digital tools, and institutional support.

One respondent expressed: *"Have a specific template that can be used by teachers."* Another stated: *"A well-structured template for SDLE."* Similarly, another highlighted: *"READY MADE LESSON PLAN PPT AND USING THIS SDLE UTILIZATION."* Other respondents emphasized broader support systems: *"seek support from stakeholders."* And *"Finding a better software or app."*

These responses indicate that teachers require clear implementation guides and structured instructional resources that can facilitate the efficient integration of SDLE into classroom practice. The findings further suggest that institutional and stakeholder support plays an important role in sustaining

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

technology-assisted instructional initiatives.

Overall, the thematic analysis complements the quantitative findings by providing deeper explanations regarding the conditions necessary for effective SDLE implementation. The results reveal that science teachers view successful SDLE utilization as dependent on three interconnected factors: teacher preparedness, availability of technological resources, and structured implementation support. These findings suggest that enhancing SDLE utilization requires a comprehensive support framework that addresses both instructional and organizational dimensions of technology integration.

The identified recommendations provided the empirical basis for the development of the proposed Structured Digital Learning Episodes modules presented in Appendix L. Specifically, the need for structured instructional guides informed the organization of the SDLE modules; the recommendation for interactive digital resources supported the inclusion of simulations and instructional videos; and the call for accessible and teacher-friendly materials guided the design of standardized lesson components and implementation procedures. Thus, the thematic findings served as an important foundation in the development of an SDLE package that is responsive to the needs and challenges identified by science teachers.

These findings support the position of CHED (2020) that effective implementation of flexible and technology-enhanced learning requires continuous capacity building, adequate resources, and institutional support systems. Similarly, OECD (2018) emphasizes that technology integration becomes most effective when accompanied by sufficient infrastructure, professional development opportunities, and coherent implementation frameworks.

Sub-problem No. 4.1. How do the science teachers and experts assess the acceptability of SDLE in terms of objectives?

Table 8 presents the assessment of Science teachers and Science experts regarding the acceptability of the Structured Digital Learning Episode (SDLE) modules in terms of objectives. The results reveal that both groups of respondents evaluated the objectives of the SDLE modules favorably, yielding an overall composite mean of 4.52, interpreted as *Highly Acceptable*. This finding indicates that the objectives embedded in the developed SDLE modules are perceived to be clear, relevant, measurable, and well-aligned with the instructional requirements of Grade 9 Science.

Table 8. *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of Objectives*

Indicators	Science Teachers			Science Experts			Composite		
	Mean	VI	R	Mean	VI	R	Mean	VI	R
1. The learning objectives are clearly stated and specific.	4.44	HA	2	4.54	HA	4	4.49	HA	4
2. The objectives are aligned with MELCs.	4.11	A	4	4.92	HA	1	4.52	HA	3
3. The objectives are measurable and achievable.	4.36	HA	3	4.69	HA	2	4.53	HA	2
4. The objectives guide the content, activities, and assessment.	4.47	HA	1	4.62	HA	3	4.54	HA	1
Overall Assessment	**4.35**	**HA**		**4.69**	**HA**		**4.52**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Note: The internal consistency reliability of the SDLE Acceptability Questionnaire was established through pilot testing, yielding a Cronbach's alpha coefficient of 0.965, indicating excellent reliability.

Among the indicators, *"The objectives guide the content, activities, and assessment"* obtained the highest composite mean of 4.54, interpreted as *Highly Acceptable* and ranked first. This was followed by "*The objectives are measurable and achievable"* with a composite mean of 4.53, and "*The objectives are aligned with MELCs"* with a composite mean of 4.52, both interpreted as *Highly Acceptable*. Meanwhile, "*The learning objectives are clearly stated and specific"* received the lowest composite mean of 4.49, although it remained within the *Highly Acceptable* category.

A closer examination of the ratings shows that Science experts consistently provided higher assessments (overall mean = 4.69) than Science teachers (overall mean = 4.35). Notably, experts assigned the highest rating to the alignment of the objectives with the Most Essential Learning Competencies (MELCs) (M = 4.92), indicating strong agreement that the SDLE modules conform to curriculum standards. Science teachers likewise rated all indicators positively, although the indicator on MELC alignment received a slightly lower rating (M = 4.11), interpreted as *Acceptable*. Nevertheless, the overall assessment from both respondent groups demonstrates a high level of confidence in the quality and appropriateness of the instructional objectives.

The findings suggest that the SDLE modules were developed with clearly articulated instructional goals that effectively serve as the foundation for the content, learning activities, and assessment components of the lessons. The high rating for the alignment of objectives with content and assessment indicates strong instructional coherence, which is a critical characteristic of quality instructional materials. When learning objectives are properly formulated and aligned with curriculum standards, they provide clear direction for both teaching and learning, thereby enhancing instructional effectiveness and supporting the attainment of desired learning outcomes.

The results support the principle of constructive alignment, which emphasizes aligning learning objectives, instructional activities, and assessment tasks to promote meaningful learning. According to McMillan (2024), well-defined and measurable objectives serve as the foundation for effective instructional design by guiding the selection of content, learning experiences, and assessment strategies. Similarly, Creswell and Guetterman (2024) noted that educational materials are more likely to achieve their intended outcomes when their objectives are clearly specified and systematically aligned with curriculum requirements.

Moreover, the findings are consistent with Rayyanah's (2025) study, which reported that instructional materials received higher acceptability ratings when evaluators perceived strong alignment among objectives, content, and assessment components. Likewise, Abareta (2025) found that clearly stated, curriculum-aligned objectives significantly contributed to the overall validity and acceptability of the developed instructional materials. These studies reinforce the present finding that the objectives of the SDLE modules constitute a major strength of the intervention and provide a sound foundation for enhancing learners' science achievement and metacognitive development.

Overall, the results indicate that the objectives of the SDLE modules are highly acceptable to both Science teachers and Science experts. The findings affirm that the developed modules possess clearly defined, measurable, and curriculum-aligned objectives that effectively guide the instructional process, thereby supporting the suitability of the SDLE modules for implementation in Grade 9 Science.

Sub-problem No. 4.2. How do the science teachers and experts assess the acceptability of SDLE in terms of content?

Table 9 presents the assessment of Science teachers and Science experts regarding the acceptability of the Structured Digital Learning Episode (SDLE) modules in terms of content. The results show that both groups of respondents rated the content component of the SDLE modules as *Highly Acceptable*, yielding an overall composite mean of 4.47. This finding indicates that the content of the developed modules possesses the essential qualities expected of effective instructional materials, including scientific accuracy, relevance, clarity, alignment with learning objectives, and the capacity to promote conceptual understanding among Grade 9 learners.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

Table 9**.** *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of* Content

Indicators		Science Teachers			Science Experts			Composite		
		Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1.	The content is scientifically accurate and up to date.	4.33	HA	3	4.38	HA	6	4.36	HA	6
2.	The content is appropriate for Grade 9 learners.	4.56	HA	1	4.46	HA	5	4.51	HA	2
3.	The content supports the stated learning objectives.	4.39	HA	2	4.69	HA	1.5	4.54	HA	1
4.	Concepts are presented clearly and logically.	4.31	HA	4	4.62	HA	3	4.46	HA	5
5.	The content promotes conceptual understanding.	4.25	HA	5	4.69	HA	1.5	4.47	HA	3
Overall Assessment		**4.37**	**HA**		**4.57**	**HA**		**4.47**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, "*The content supports the stated learning objectives"* obtained the highest composite mean of 4.54, interpreted as *Highly Acceptable* and ranked first. This was followed by "*The content is appropriate for Grade 9 learners"* with a composite mean of 4.51, and *"The content promotes conceptual understanding"* with a composite mean of 4.47, both interpreted as *Highly Acceptable.* Meanwhile, "*Concepts are presented clearly and logically" and "The content is scientifically accurate and up to date"* obtained composite means of 4.46 and 4.36, respectively, and were likewise interpreted as *Highly Acceptable.*

The findings further reveal that Science experts provided a slightly higher overall assessment (M = 4.57) than Science teachers (M = 4.37). Among the experts, the indicators *"The content supports the stated learning objectives"* and *"The content promotes conceptual understanding"* received the highest ratings (M = 4.69), reflecting strong agreement regarding the instructional value of the developed content. Science teachers, on the other hand, assigned the highest rating to *"The content is appropriate for Grade 9 learners" (M = 4.56),* indicating that the lessons, examples, and learning tasks were considered suitable for the learners' developmental level and academic needs.

The results suggest that the content of the SDLE modules is effectively aligned with the intended learning outcomes and can facilitate meaningful learning experiences. The highest-rated indicator demonstrates that the content was carefully selected and organized to directly support the attainment of the stated objectives. Likewise, the high ratings for appropriateness and conceptual understanding indicate that the modules provide learners with opportunities to develop deeper comprehension of scientific concepts rather than merely acquiring factual knowledge. The favorable assessment of clarity and logical presentation further implies that the content was structured to promote learner understanding and minimize misconceptions.

These findings are consistent with the principles of instructional design, which emphasize that effective learning materials should contain accurate, relevant, and learner-centered content that aligns with intended educational outcomes. According to McMillan (2024), instructional content must be carefully aligned with learning objectives to ensure coherence and maximize learning effectiveness. Similarly, Creswell and Guetterman (2024) noted that educational materials are considered valid and useful when their content is accurate, appropriate for the target learners, and capable of supporting the achievement of instructional goals.

The findings also support the work of García-Martínez et al. (2023), who found that digital science resources contribute significantly to learner understanding when the content is well-structured, scientifically accurate, and aligned with curriculum standards. Likewise, Davis (2024) reported that instructional materials designed with clear explanations and conceptually rich content promote higher levels

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of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

of comprehension and engagement among science learners. Furthermore, Williams (2023) emphasized that effective digital science materials facilitate conceptual understanding by presenting scientific ideas through organized, learner-friendly, and inquiry-oriented content.

Overall, the results indicate that the content component of the SDLE modules is highly acceptable to both Science teachers and Science experts. The findings affirm that the modules contain scientifically accurate, curriculum-aligned, and developmentally appropriate content that effectively supports learning objectives and promotes conceptual understanding. These characteristics demonstrate the quality of the developed SDLE modules and support their suitability for implementation in Grade 9 Science instruction.

Sub-problem No. 4.3. How do the science teachers and experts assess the acceptability of SDLE in terms of activities?

Table 10 presents the assessment by Science teachers and Science experts of the acceptability of the Structured Digital Learning Episode (SDLE) modules in terms of their activities. The results reveal that the activities embedded in the SDLE modules were evaluated favorably by both groups of respondents, obtaining an overall composite mean of **4.43**, interpreted as *Highly Acceptable.* This finding indicates that the learning activities included in the modules are considered relevant, engaging, and appropriate for facilitating the attainment of the intended learning outcomes in Grade 9 Science.

Table 10**.** *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of* Activities

	Indicators	Science Teachers			Science Experts			Composite		
		Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1.	Activities are aligned with the learning objectives.	4.42	HA	1	4.92	HA	1	4.67	HA	1
2.	Activities promote active learner engagement.	4.22	HA	2	4.46	HA	4.5	4.34	HA	4
3.	Activities encourage critical thinking and problem-solving.	4.03	A	5	4.77	HA	2	4.40	HA	3
4.	Activities support inquiry-based learning.	4.14	A	4	4.69	HA	3	4.42	HA	2
5.	Activities are appropriate for learners' abilities.	4.17	A	3	4.46	HA	4.5	4.31	HA	5
	Overall Assessment	**4.19**	**A**		**4.66**	**HA**		**4.43**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, "*Activities are aligned with the learning objectives"* received the highest composite mean of 4.67, interpreted as *Highly Acceptable* and ranked first. This was followed by *"Activities support inquiry-based learning"* with a composite mean of 4.42, and *"Activities encourage critical thinking and problem-solving"* with a composite mean of 4.40, both interpreted as *Highly Acceptable.* The indicator *"Activities promote active learner engagement"* obtained a composite mean of 4.34, while *"Activities are appropriate for learners' abilities"* received the lowest composite mean of 4.31. Despite being ranked last, the latter remained within the *Highly Acceptable* category.

A comparison of the ratings shows that Science experts provided a higher overall assessment (M = 4.66, Highly Acceptable) than Science teachers (M = 4.19, Acceptable). Notably, Science teachers rated three indicators—activities that encourage critical thinking and problem-solving (M = 4.03), support inquiry-based learning (M = 4.14), and are appropriate for learners' abilities (M = 4.17)—as merely *Acceptable*, whereas Science experts evaluated all indicators as *Highly Acceptable.* This difference suggests that teachers, being directly involved in classroom implementation, may have a more cautious assessment of how learners interact with the activities in actual instructional settings. Nevertheless, the composite ratings from both groups affirm the overall acceptability of the activities included in the SDLE modules.

The findings suggest that the activities were carefully designed to support the instructional objectives and to promote meaningful learner participation. The highest rating given to the alignment of

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International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

activities with learning objectives indicates that the tasks and exercises were intentionally developed to reinforce the competencies targeted in each lesson. Likewise, the high ratings for inquiry-based learning and critical thinking demonstrate that the activities encourage learners to investigate scientific phenomena, analyze information, and apply concepts in solving problems. Such characteristics are essential in science education, where learners are expected to develop not only content knowledge but also higher-order thinking skills and scientific reasoning.

The favorable evaluation of learner engagement further suggests that the activities provide opportunities for active participation rather than passive reception of information. Through structured tasks, guided explorations, and interactive digital experiences, learners are encouraged to become actively involved in constructing knowledge. Moreover, the positive assessment regarding appropriateness for learners' abilities indicates that the activities are generally suited to the developmental and cognitive characteristics of Grade 9 students, thereby increasing the likelihood of successful learning experiences.

These findings support the principles of learner-centered and inquiry-based instruction, which emphasize the role of meaningful activities in promoting deep learning. According to McMillan (2024), instructional activities should be directly aligned with learning objectives and designed to engage learners in the active construction of knowledge. Similarly, Creswell and Guetterman (2024) emphasized that educational materials become more effective when learning experiences are structured to encourage participation, critical thinking, and application of concepts.

The findings are likewise consistent with the work of Dignath and Veenman (2021), who found that instructional activities that promote strategy use, reflection, and active engagement contribute significantly to meaningful learning and self-regulation. In addition, Panadero et al. (2022) emphasized that activities incorporating inquiry, reflection, and formative learning experiences foster deeper understanding and improve learners' capacity to regulate their own learning. Furthermore, Anderson (2023) reported that digital inquiry-based science activities enhance learner engagement and facilitate the development of critical thinking skills, particularly when activities are aligned with clearly defined learning outcomes.

Overall, the results indicate that the activities incorporated in the SDLE modules are highly acceptable to both Science teachers and Science experts. The findings affirm that the activities are well-aligned with instructional objectives, promote inquiry and critical thinking, encourage learner engagement, and are generally appropriate for Grade 9 learners. These qualities demonstrate the instructional strength of the SDLE modules and support their potential to facilitate meaningful and effective science learning experiences.

Sub-problem No. 4.4. How do the science teachers and experts assess the acceptability of SDLE in terms of usefulness?

Table 11 presents the assessment of science teachers and science experts regarding the acceptability of the Structured Digital Learning Episodes (SDLE) modules in terms of usefulness. The results reveal that both groups of respondents evaluated the usefulness of the SDLE modules favorably. Science teachers obtained an overall mean of 4.31, interpreted as *Highly Acceptable*, while science experts registered a higher overall mean of 4.63, also interpreted as *Highly Acceptable*. The composite mean of 4.47 further indicates that the usefulness of the SDLE modules was *Highly Acceptable* to the respondents.

Table 11. *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of* Usefulness

	Indicators	Science Teachers			Science Experts			Composite		
		Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1.	The modules are useful for teaching Science concepts.	4.39	HA	2.5	4.69	HA	2	4.54	HA	1.5
2.	The modules support independent learning.	4.39	HA	2.5	4.69	HA	2	4.54	HA	1.5
3.	The modules enhance learner engagement.	4.42	HA	1	4.46	HA	5	4.44	HA	4
4.	The modules are applicable in blended/distance	4.03	A	5	4.69	HA	2	4.36	HA	5

learning.						
Overall Assessment	**4.31**	**HA**	**4.63**	**HA**	**4.47**	**HA**

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, *"The modules are useful for teaching Science concepts"* and *"The modules support independent learning"* obtained the highest composite mean of 4.54 and shared the first rank. This finding suggests that the respondents strongly recognized the value of the SDLE modules as effective instructional resources that facilitate the delivery of Science concepts while simultaneously promoting learner autonomy. The result reflects the modules' capacity to provide structured learning experiences that enable learners to access content, complete activities, and assess their understanding independently. Such a finding is consistent with the work of Schraw et al. (2024), who emphasized that well-designed learning materials support self-regulated learning by providing learners with opportunities to monitor and manage their own learning processes. Likewise, Dignath and Veenman (2021) highlighted that instructional materials embedded with learning strategies can foster learner independence and self-regulation.

The indicator *"The modules enhance learner engagement"* obtained a composite mean of 4.44, ranking fourth, while still receiving a *Highly Acceptable* interpretation. This indicates that the respondents perceived the SDLE modules as capable of maintaining learner interest and active participation during instruction. The finding supports the observations of García-Martínez et al. (2023) that digital learning resources contribute positively to student engagement when designed with interactive and learner-centered features. Similarly, Sung, Chang, and Liu (2019) reported that technology-enhanced learning environments improve learner participation and academic performance through increased interaction and engagement.

Meanwhile, *"The modules are applicable in blended/distance learning"* received the lowest composite mean of 4.36, although it remained within the *Highly Acceptable* range. The relatively lower rating may suggest that some respondents still recognize contextual limitations associated with technology access, connectivity, or implementation conditions in blended and distance learning environments. Nevertheless, the result demonstrates that the SDLE modules are generally viewed as practical and adaptable instructional materials across various learning modalities. This finding is supported by *Hodges et al. (2020)* and *Bond et al. (2021)*, who emphasized the importance of flexible and well-structured digital learning resources in supporting continuity of instruction across online and blended learning settings.

A comparison of the ratings shows that science experts consistently assigned higher mean scores than science teachers across all indicators. While science teachers rated one indicator as merely *Acceptable* (*M = 4.03*), science experts rated all indicators as *Highly Acceptable*. This difference may be attributed to the experts' broader experience in instructional evaluation and curriculum implementation, enabling them to recognize the pedagogical strengths and practical applications of the modules more comprehensively.

Overall, the findings indicate that the SDLE modules are *Highly Acceptable in terms of usefulness*, demonstrating their effectiveness as instructional resources that support concept learning, encourage independent learning, enhance learner engagement, and provide flexibility for blended and distance learning environments. These results suggest that the developed modules possess substantial practical value and can serve as effective tools for improving Science instruction among Grade 9 learners.

Sub-problem No. 4.5. How do the science teachers and experts assess the acceptability of SDLE in terms of language and style?

Table 12 presents the assessment of science teachers and science experts regarding the acceptability of the Structured Digital Learning Episodes (SDLE) modules in terms of language and style. The findings reveal that both groups of respondents regarded the language and style of the SDLE modules favorably. Science teachers obtained an overall mean of 4.23, interpreted as *Highly Acceptable*, while science experts registered a higher overall mean of 4.56, likewise interpreted as *Highly Acceptable*. The composite mean of 4.39 indicates that the language and style of the SDLE modules are *Highly Acceptable* to the respondents.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

Table 12. *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of Language and Style*

Indicators		Science Teachers			Science Experts			Composite		
		Mean	VI	R	Mean	VI	R	Mean	VI	R
1.	The SDLE modules are effective instructional tools.	4.36	HA	2	4.46	HA	3	4.41	HA	2
2.	I am satisfied with the SDLE modules.	4.31	HA	3	4.38	HA	4	4.35	HA	3
3.	I intend to use/recommend SDLE modules in teaching.	4.39	HA	1	4.69	HA	1.5	4.54	HA	1
4.	Scientific terms are properly explained.	3.86	A	4	4.69	HA	1.5	4.28	HA	4
Overall Assessment		**4.23**	**HA**		**4.56**	**HA**		**4.39**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, *"I intend to use/recommend SDLE modules in teaching"* obtained the highest composite mean of 4.54, interpreted as *Highly Acceptable.* Science teachers rated this indicator with a mean of 4.39, while science experts rated it higher at 4.69. This finding suggests that the respondents have a strong level of confidence in the quality and effectiveness of the SDLE modules, making them willing to utilize and recommend the materials in Science instruction. The high rating implies that the modules possess language and stylistic features that facilitate understanding, engagement, and instructional effectiveness. This finding supports the Technology Acceptance Model of Davis (1989), which posits that users are more likely to adopt and recommend educational technologies when they perceive them as useful and easy to use. The result likewise aligns with the findings of Trust and Whalen (2020), who emphasized that well-designed digital instructional materials enhance teacher acceptance and integration of technology in classroom instruction.

The indicator *"The SDLE modules are effective instructional tools"* ranked second with a composite mean of 4.41, while *"I am satisfied with the SDLE modules"* ranked third with a composite mean of 4.35. Both indicators were interpreted as *Highly Acceptable,* indicating that respondents viewed the modules as effective learning resources and expressed satisfaction with their overall design and presentation. These findings suggest that the language used in the modules contributes positively to their instructional value by facilitating clarity, comprehension, and learner engagement. This observation is consistent with Alqurashi (2022), who found that instructional design quality significantly influences learners' perceptions of effectiveness and engagement in digital learning environments.

The indicator *"Scientific terms are properly explained"* received the lowest composite mean of 4.28, although it remained within the *Highly Acceptable* range. A notable difference was observed between the ratings of science teachers (M = 3.86, Acceptable) and science experts (M = 4.69, Highly Acceptable). This disparity may indicate that classroom teachers, who directly observe learners' comprehension difficulties, perceive a greater need for additional explanations or simplification of certain scientific terminologies. Nevertheless, the overall rating suggests that respondents generally agree that scientific concepts and terms are presented in a manner that supports learner understanding. This finding is supported by García-Martínez et al. (2023), who emphasized that the clarity and comprehensibility of digital learning materials are critical factors in promoting effective science learning and conceptual understanding.

A comparison of the ratings further reveals that science experts consistently assigned higher mean scores than science teachers across all indicators. While science teachers rated one indicator as merely *Acceptable,* science experts evaluated all indicators as *Highly Acceptable.* This difference may be attributed to the experts' broader experience in curriculum evaluation and instructional material assessment, which enables them to appreciate the modules' strengths from pedagogical and content-design perspectives.

Overall, the findings indicate that the SDLE modules are *Highly Acceptable in terms of language and style.* The high ratings demonstrate that the modules employ clear, appropriate, and pedagogically sound language that contributes to instructional effectiveness, user satisfaction, and willingness to adopt the materials in Science teaching. These results suggest that the language and stylistic features of the SDLE modules effectively support learner comprehension and enhance their value as instructional resources for Grade 9 Science.

Sub-problem No. 4.6. How do the science teachers and experts assess the acceptability of SDLE in terms of organization?

Table 13 presents the assessment of science teachers and science experts regarding the acceptability of the Structured Digital Learning Episodes (SDLE) modules in terms of organization. The findings indicate that both groups of respondents rated the organizational structure of the SDLE modules very favorably. Science teachers obtained an overall mean of 4.42, interpreted as *Highly Acceptable*, while science experts recorded a higher overall mean of 4.77, likewise interpreted as *Highly Acceptable.* The composite mean of 4.59 demonstrates that the organization of the SDLE modules is *Highly Acceptable* to the respondents.

Table 13.*Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of Organization*

	Indicators	Science Teachers			Science Experts			Composite		
		Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1.	The module follows a logical sequence (objective → content → activity → assessment → reflection).	4.31	HA	2.5	4.77	HA	2	4.54	HA	2.5
2.	The flow of the lesson is coherent.	4.31	HA	2.5	4.77	HA	2	4.54	HA	2.5
3.	Sections are well structured and organized.	4.64	HA	1	4.77	HA	2	4.70	HA	1
	Overall Assessment	**4.42**	**HA**		**4.77**	**HA**		**4.59**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, *"Sections are well structured and organized"* obtained the highest composite mean of 4.70, interpreted as *Highly Acceptable.* Science teachers rated this indicator at 4.64, while science experts rated it at 4.77. This finding suggests that the arrangement of the module components facilitated a clear, systematic presentation of learning content, making it easier for both teachers and learners to navigate the lessons. The result implies that the SDLE modules were developed with careful attention to instructional sequencing and content organization, which are essential elements in facilitating meaningful learning experiences. This finding supports the work of Zheng (2021), who emphasized that structured online learning designs enhance learner engagement and conceptual understanding by providing clear learning pathways. Similarly, Hodges et al. (2020) highlighted the importance of well-organized digital instructional materials in supporting effective learning experiences.

The indicators *"The module follows a logical sequence (objective → content → activity → assessment → reflection)"* and *"The flow of the lesson is coherent"* both obtained a composite mean of 4.54, sharing the second rank and receiving a *Highly Acceptable* interpretation. These results indicate that respondents perceived the modules as having a coherent progression of learning activities, allowing learners to move systematically from one instructional component to another. The logical sequencing of objectives, content, activities, assessments, and reflections reflects sound instructional design principles that help learners connect ideas and develop a deeper understanding of scientific concepts. This finding is consistent with Dignath and Veenman (2021), who noted that structured instructional designs support self-regulated learning by providing learners with clear guidance and organized learning pathways. Likewise, Schraw et al. (2024) emphasized that well-sequenced instructional materials facilitate cognitive processing and metacognitive regulation.

A comparison of the responses reveals that science experts consistently assigned higher ratings than science teachers across all indicators. While both groups rated the indicators as *Highly Acceptable*, the higher ratings from experts may be attributed to their extensive experience in instructional supervision,

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of Education, Research, and Innovation Perspectives
Volume 2 Issue 8 (August 2026)

curriculum implementation, and evaluation of learning resources. Their assessments suggest strong confidence in the structural integrity and pedagogical organization of the developed modules.

Overall, the findings indicate that the SDLE modules are *Highly Acceptable in terms of organization.* The high ratings demonstrate that the modules follow a logical sequence, have a coherent lesson flow, and feature well-structured sections that collectively support effective teaching and learning. These results suggest that the organizational design of the SDLE modules facilitates learner comprehension, promotes smooth instructional delivery, and enhances the overall quality of the learning experience for Grade 9 Science learners.

Sub-problem No. 4.7. How do the science teachers and experts assess the acceptability of SDLE in terms of presentation?

Table 14 presents the assessment of science teachers and science experts regarding the acceptability of the Structured Digital Learning Episodes (SDLE) modules in terms of presentation. The results indicate that both groups of respondents viewed the presentation features of the SDLE modules very positively. Science teachers obtained an overall mean of 4.38, interpreted as *Highly Acceptable*, while science experts recorded a higher overall mean of 4.62, likewise interpreted as *Highly Acceptable.* The composite mean of 4.50 further demonstrates that the presentation of the SDLE modules is *Highly Acceptable* to the respondents.

Table 14**.** *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of Presentation*

Indicators		Science Teachers			Science Experts			Composite		
		Mean	VI	R	Mean	VI	R	Mean	VI	R
1.	The layout is visually appealing.	4.17	A	4	4.46	HA	4	4.31	HA	4
2.	Multimedia elements enhance learning.	4.39	HA	3	4.54	HA	3	4.46	HA	3
3.	The design supports readability.	4.42	HA	2	4.69	HA	2	4.55	HA	2
4.	The module is accessible across devices.	4.56	HA	1	4.77	HA	1	4.66	HA	1
Overall Assessment		**4.38**	**HA**		**4.62**	**HA**		**4.50**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, *"The module is accessible across devices"* obtained the highest composite mean of 4.66, interpreted as *Highly Acceptable.* Science teachers rated this indicator at 4.56, while science experts rated it at 4.77. This finding suggests that the SDLE modules can be effectively accessed and utilized through various digital devices, making them adaptable to diverse learning environments and technological conditions. Accessibility is a critical feature of digital instructional materials because it ensures that learners can engage with learning content regardless of the device available to them. This result supports the findings of Bond et al. (2021), who emphasized that accessibility and flexibility are essential characteristics of effective digital learning resources, particularly in technology-supported and blended learning environments.

The indicator *"The design supports readability"* ranked second with a composite mean of 4.55, followed by *"Multimedia elements enhance learning"* with a composite mean of 4.46, both interpreted as *Highly Acceptable.* These findings indicate that the respondents perceived the visual design, formatting, and multimedia features of the SDLE modules as supportive of learning and comprehension. The high ratings suggest that the modules effectively present information in a manner that is easy to read, understand, and process. Moreover, the inclusion of multimedia elements appears to contribute positively to learner engagement and conceptual understanding. These findings are consistent with García-Martínez et al. (2023), who reported that digital resources incorporating multimedia components enhance educational outcomes by improving engagement and supporting the visualization of scientific concepts. Likewise, Kim and Xie (2021) emphasized that well-designed multimedia materials can reduce cognitive load and facilitate more meaningful learning experiences.

The indicator *"The layout is visually appealing"* received the lowest composite mean of 4.31, although it remained within the *Highly Acceptable* range. A slight difference was observed between the ratings of science teachers (M = 4.17, Acceptable) and science experts (M = 4.46, Highly Acceptable). This result may indicate that while the overall visual presentation was positively received, some teachers perceived opportunities for further enhancement of aesthetic features such as graphics, color schemes, or page design. Nevertheless, the composite rating suggests that the visual layout of the modules is generally effective and contributes positively to the overall learning experience. This finding aligns with Davis (2024), who noted that attractive and well-designed digital learning materials improve learner attention, engagement, and conceptual understanding in science education.

A comparison of the ratings reveals that science experts consistently assigned higher mean scores than science teachers across all indicators. While one indicator was rated merely *Acceptable* by science teachers, all indicators were rated *Highly Acceptable* by the science experts. This difference may be attributed to the experts' broader perspective in evaluating instructional materials and their familiarity with standards for digital resource design and presentation.

Overall, the findings indicate that the SDLE modules are *Highly Acceptable in terms of presentation.* The high ratings demonstrate that the modules possess strong presentation features characterized by accessibility, readability, effective multimedia integration, and visually appropriate design. These qualities contribute to a positive learning experience and enhance the effectiveness of the SDLE modules as instructional resources for Grade 9 Science learners.

Sub-problem No. 4.8. How do the science teachers and experts assess the acceptability of SDLE in terms of evaluation?

Table 15 presents the assessment of science teachers and science experts regarding the acceptability of the Structured Digital Learning Episodes (SDLE) modules in terms of evaluation. The findings reveal that both groups of respondents rated the evaluation component of the SDLE modules very positively. Science teachers obtained an overall mean of 4.36, interpreted as *Highly Acceptable*, while science experts registered a higher overall mean of 4.69, also interpreted as *Highly Acceptable.* The composite mean of 4.53 indicates that the evaluation component of the SDLE modules is *Highly Acceptable* to the respondents.

Table 15. *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of* Evaluation

Indicators	Science Teachers			Science Experts			Composite		
	Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1. Assessments align with the learning objectives.	4.36	HA	3	4.69	HA	2.5	4.53	HA	3
2. Assessment items are clear and appropriate.	3.92	A	4	4.69	HA	2.5	4.30	HA	4
3. The module includes formative assessments.	4.58	HA	1.5	4.69	HA	2.5	4.64	HA	1.5
4. Feedback provided is useful for learning.	4.58	HA	1.5	4.69	HA	2.5	4.64	HA	1.5
Overall Assessment	**4.36**	**HA**		**4.69**	**HA**		**4.53**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, *"The module includes formative assessments"* and *"Feedback provided is useful for learning"* both obtained the highest composite mean of 4.64, sharing the first rank and receiving a *Highly Acceptable* interpretation. Science teachers rated both indicators at 4.58, while science experts assigned identical means of 4.69. These findings suggest that the SDLE modules effectively incorporate formative assessment practices and meaningful feedback mechanisms that support learner progress throughout the learning process. The inclusion of formative assessments enables learners to monitor their understanding, identify misconceptions, and make necessary adjustments in their learning strategies.

Likewise, timely and constructive feedback helps learners improve their performance and deepen their conceptual understanding. These findings support the work of Panadero, Broadbent, Boud, and Lodge (2022), who emphasized that formative assessment plays a critical role in promoting self-regulated learning by helping learners monitor, evaluate, and improve their learning processes. Similarly, Wilson (2024) highlighted the importance of feedback systems in digital learning environments for enhancing metacognitive regulation and academic achievement.

The indicator *"Assessments align with the learning objectives"* ranked third with a composite mean of 4.53, interpreted as *Highly Acceptable.* This result indicates that respondents perceived a strong alignment between the assessment tasks and the intended learning outcomes of the SDLE modules. Such alignment is essential in ensuring that assessments accurately measure the competencies targeted by instruction and provide valid evidence of learner achievement. The finding supports the principle of constructive alignment, which emphasizes the consistency among learning objectives, instructional activities, and assessment tasks. This observation is consistent with the work of Dignath and Veenman (2021), who stressed that effective instructional materials should provide coherent connections among learning goals, activities, and evaluation processes.

The indicator *"Assessment items are clear and appropriate"* had the lowest composite mean of 4.30, yet remained within the *Highly Acceptable* range. A notable difference was observed between the ratings of science teachers (M = 3.92, Acceptable) and science experts (M = 4.69, Highly Acceptable). This disparity may suggest that teachers, who directly observe learners' responses to assessment tasks, perceive some opportunities for further refinement in the wording, complexity, or presentation of assessment items. Nevertheless, the overall rating indicates that respondents generally considered the assessment items to be suitable and understandable for Grade 9 learners. This finding aligns with Johnson (2024), who emphasized that clear, well-designed assessment items contribute to more accurate measurement of learning outcomes and improved learner performance.

A comparison of the ratings reveals that science experts consistently assigned higher scores than science teachers across all indicators. While one indicator was rated merely *Acceptable* by science teachers, science experts evaluated all indicators as *Highly Acceptable.* This difference may be attributed to the experts' extensive experience in curriculum evaluation and instructional material review, enabling them to assess the quality of assessment components from a broader pedagogical perspective.

Overall, the findings indicate that the SDLE modules are *Highly Acceptable based on the evaluation.* The high ratings demonstrate that the modules incorporate well-aligned assessments, meaningful formative evaluation activities, and useful feedback mechanisms that support learning and achievement. These results suggest that the evaluation component of the SDLE modules effectively facilitates monitoring of learner progress and contributes to the development of meaningful, measurable learning outcomes among Grade 9 Science learners.

Sub-problem No. 4.9. How do the science teachers and experts assess the acceptability of SDLE in terms of navigation?

Table 16 presents the assessment of science teachers and science experts regarding the acceptability of the Structured Digital Learning Episodes (SDLE) modules in terms of navigation. The results reveal that both groups evaluated the modules' navigation features as Highly Acceptable, as evidenced by overall mean ratings of 4.29 from science teachers and 4.73 from science experts. The composite overall mean of 4.51, interpreted as *Highly Acceptable*, indicates that the SDLE modules possess user-friendly navigation features that enable learners and teachers to access and utilize the instructional content efficiently.

Table 16. *Assessment of the Respondents of the Acceptability of the SDLE Modules in Terms of* Navigation

Indicators	**Science Teachers**			**Science Experts**			**Composite**		
	Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1. The module is easy to navigate.	4.25	HA	3	4.85	HA	1	4.55	HA	2
2. Instructions for navigation are clear.	4.22	HA	4	4.69	HA	3	4.46	HA	4
3. Links and buttons function properly.	4.42	HA	1	4.69	HA	3	4.55	HA	1
4. Users can easily locate content and activities.	4.28	HA	2	4.69	HA	3	4.49	HA	3
Overall Assessment	**4.29**	**HA**		**4.73**	**HA**		**4.51**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Among the indicators, *"Links and buttons function properly"* and "*The module is easy to navigate"* obtained the highest composite mean of 4.55, both interpreted as *Highly Acceptable* and ranked first and second, respectively. These findings suggest that the technical functionality and ease of movement within the module were among its strongest features. The high ratings indicate that respondents perceived the SDLE as reliable and intuitive, allowing users to access learning resources, activities, and assessments with minimal difficulty. This is particularly important in digital learning environments, where smooth navigation contributes to learner engagement and reduces the cognitive load associated with navigating instructional materials.

The indicator "*Users can easily locate content and activities" o*btained a composite mean of 4.49, while *"Instructions for navigation are clear"* received the lowest composite mean of 4.46. Although ranked lowest, the latter remained within the *Highly Acceptable* range, indicating that respondents generally found the navigational instructions understandable and sufficient. The slightly lower rating suggests that minor enhancements to navigation cues, labels, or user guidance could further improve the usability of the modules, particularly for learners with limited experience with digital learning materials.

A comparison of the ratings further shows that science experts consistently assigned higher scores than science teachers across all indicators. The highest expert rating was for "The module is easy to navigate" (M = 4.85), indicating strong agreement among experts on the effectiveness of the module's navigation structure. Meanwhile, science teachers rated *"Links and buttons function properly"* highest (M = 4.42), reflecting their appreciation of the module's technical functionality during actual use. Despite these differences, both groups shared the perception that the SDLE modules provide a clear, organized, and accessible learning environment.

The findings indicate that the developed SDLE modules successfully incorporated essential principles of digital instructional design, particularly usability and accessibility. Effective navigation allows learners to focus on learning tasks rather than on figuring out how to operate the module, thereby supporting a more efficient and engaging learning experience. The logical organization of content, functional interactive elements, and clear navigational pathways contribute to the overall quality and effectiveness of the modules as digital learning resources.

These findings are supported by the work of Davis, F. D. (1989), who emphasized that perceived ease of use significantly influences users' acceptance of educational technologies. Similarly, the study of García-Martínez, J. A. et al. (2023) found that well-designed digital resources enhance learner engagement and instructional effectiveness when navigation is intuitive and accessible. Moreover, the findings align with those of Alqurashi, E. (2022), who reported that students' perceptions of learning effectiveness in online environments are positively influenced by clear instructional design and ease of platform navigation. Collectively, these studies support the present finding that the navigation features of the SDLE modules are highly acceptable and contribute significantly to their instructional value and usability.

Table 17. *Summary Assessment of the Acceptability of the SDLE Modules*

Criteria	**Science Teachers**			**Science Experts**			**Composite**		
	Mean	**VI**	**R**	**Mean**	**VI**	**R**	**Mean**	**VI**	**R**
1. Objectives	4.35	HA	5	4.69	HA	4	4.52	HA	3
2. Content	4.37	HA	3	4.57	HA	8	4.47	HA	7
3. Activities	4.19	A	9	4.66	HA	5	4.43	HA	8
4. Usefulness	4.31	HA	6	4.63	HA	6	4.47	HA	6
5. Language and Style	4.23	HA	8	4.56	HA	9	4.39	HA	9
6. Organization	4.42	HA	1	4.77	HA	1	4.59	HA	1
7. Presentation	4.38	HA	2	4.62	HA	7	4.50	HA	5
8. Evaluation	4.36	HA	4	4.69	HA	3	4.53	HA	2
9. Navigation	4.29	HA	7	4.73	HA	2	4.51	HA	4
Overall Assessment	**4.32**	**HA**		**4.66**	**HA**		**4.49**	**HA**	

Legend: (Assessment Indicators) VI – Verbal Interpretation; R – Rank. (Verbal Interpretation) HA – Highly Acceptable; A – Acceptable; MA – Moderately Acceptable; LA – Least Acceptable; NA – Not Acceptable

Table 17 presents a summary assessment of the acceptability of the Structured Digital Learning Episodes (SDLE) modules, evaluated by science teachers and science experts across nine criteria. Based on the composite rankings, Organization emerged as the highest-rated criterion (M = 4.59, Rank 1), followed by Evaluation (M = 4.53, Rank 2), Objectives (M = 4.52, Rank 3), and Navigation (M = 4.51, Rank 4). These results indicate that the respondents highly valued the systematic structure of the modules, the alignment and quality of assessment components, the clarity of learning objectives, and the ease of navigating the digital materials. Meanwhile, Presentation (Rank 5), Usefulness (Rank 6), and Content (Rank 7) received slightly lower yet still highly acceptable ratings, suggesting that these aspects adequately supported learning but were perceived as secondary to the modules' organizational and instructional design features. The lowest-ranked criteria were Activities (M = 4.43, Rank 8) and Language and Style (M = 4.39, Rank 9). Although these dimensions remained within the Highly Acceptable range, their relatively low rankings suggest that respondents perceived greater opportunities for improvement in the variety and complexity of learning activities, as well as in the clarity, consistency, and learner-friendliness of the language used in the modules. The overall ranking pattern suggests that respondents prioritized structural quality, alignment, and functionality over aesthetic and linguistic features, indicating that the SDLE modules were primarily valued for their effectiveness as organized and instructionally sound learning resources.

Sub-problem No. 5. Is there a significant difference between the Grade 9 learners' achievement and metacognition before and after using the SDLE?

The effectiveness of the Structured Digital Learning Episodes (SDLE) was examined by comparing the science achievement and metacognition levels of Grade 9 learners before and after exposure to the intervention. Prior to conducting the test of significance, the assumptions of normality were examined using the Shapiro–Wilk Test. The results revealed that the pre-intervention achievement scores ($p = .010$), post-intervention knowledge of cognition scores ($p = .004$), and pre-intervention regulation of cognition scores ($p = .019$) significantly deviated from normality. Consequently, the nonparametric Wilcoxon Signed-Rank Test was employed to determine whether significant differences existed between the pretest and posttest scores.

The distribution of learners' science achievement levels before and after the implementation of the SDLE is presented in Table 18.

Table 18. *Science Achievement of Grade 9 Learners Before and After Using the SDLE Modules*

Achievement Level	Pre-Intervention		Post-Intervention	
	Freq.	%	Freq.	%
Outstanding	-	-	14	17.5%
Very Satisfactory	21	26.3%	44	55.0%
Satisfactory	49	61.3%	21	26.3%
Fairly Satisfactory	10	12.5%	1	1.3%
Did Not Meet Expectations	-	-	-	-

Prior to the intervention, the majority of learners were classified under the *Satisfactory* level (61.3%), followed by *Very Satisfactory* (26.3%) and *Fairly Satisfactory* (12.5%). After exposure to the SDLE modules, a marked improvement in performance was observed. More than half of the learners (55.0%) achieved the *Very Satisfactory* level, while 17.5% attained the *Outstanding* level. The proportion of learners in the *Satisfactory* category decreased from 61.3% to 26.3%, and only one learner (1.3%) remained in the *Fairly Satisfactory* category. The absence of learners under the *Did Not Meet Expectations* category in both assessments further reflects the generally favorable academic standing of the participants.

Table 19. *Median Achievement Scores Before and After the Use of SDLE Modules*

Pre-test	Post-test	T	Z	p	Decision	Interpretation
13.49 (3.39)	20.83 (3.80)	43.00	-7.53	.000	Reject H_0	Significant Difference

To determine whether the observed improvement was statistically significant, the Wilcoxon Signed-Rank Test was performed. As shown in Table 19, the median achievement score increased from *13.49 (SD = 3.39)* during the pretest to *20.83 (SD = 3.80)* during the posttest. The computed test statistic yielded $T = 43.00$, $Z = -7.53$, *and* $p = .000$, which is less than the 0.05 level of significance. Thus, the null hypothesis was rejected, indicating a *significant difference* between the science achievement scores before and after the use of the SDLE modules. The findings suggest that the intervention substantially improved learners' mastery of the targeted science competencies. This result supports the findings of Miller (2022), who reported that structured digital modules significantly enhanced middle school students' academic performance, and Garcia (2022), who found that multimedia-based instruction positively influenced science achievement. Similarly, Davis (2024) and Williams (2023) emphasized that interactive digital learning environments and technology-supported inquiry activities promote deeper conceptual understanding and improved learning outcomes in science education.

The effect of the SDLE on learners' metacognition was likewise examined. Table 20 presents the levels of metacognition in terms of *Knowledge of Cognition* before and after the intervention.

Table 20. *Metacognition in Terms of Knowledge of Cognition of Grade 9 Learners Before and After Using the SDLE Modules*

Level of Metacognition	Pre-Intervention		Post-Intervention	
	Freq.	%	Freq.	%
Highly Evident	3	3.8%	6	7.5%
Evident	18	22.5%	52	65.0%
Moderately Evident	53	66.3%	16	20.0%
Least Evident	6	7.5%	6	7.5%
Very Least Evident	-	-	-	-

Before using the SDLE modules, the majority of learners (66.3%) were classified as *Moderately Evident*, while only 22.5% were categorized as *Evident* and 3.8% as *Highly Evident*. Following the intervention, a substantial shift in distribution occurred. The proportion of learners classified as *Evident* increased dramatically to 65.0%, while those categorized as *Moderately Evident* decreased to 20.0%. The percentage of learners exhibiting *Highly Evident* metacognitive knowledge also increased from 3.8% to 7.5%.

Table 21
Median Knowledge of Cognition Scores Before and After the Use of SDLE Modules

Pre-test	Post-test	T	Z	p	Decision	Interpretation
3.21 (0.49)	3.58 (0.52)	47.50	-7.23	.000	Reject H_0	Significant Difference

The significance of this improvement was verified through the Wilcoxon Signed-Rank Test. Table 21 shows that the median Knowledge of Cognition score increased from *3.21 (SD = 0.49)* to *3.58 (SD = 0.52)*. The test yielded *T = 47.50, Z = -7.23,* and *p = .000,* leading to the rejection of the null hypothesis. Therefore, a *significant difference* existed between the learners' knowledge of cognition before and after the implementation of the SDLE modules. This finding indicates that the intervention strengthened learners' awareness of their own learning processes, including their understanding of strategies, strengths, limitations, and conditions for effective learning. The result corroborates the work of Schraw et al. (2024) and Veenman et al. (2017), who emphasized that well-designed learning environments promote metacognitive knowledge by encouraging learners to reflect on and regulate their thinking processes. Likewise, Lee (2023) and Chen (2023) reported that digital learning modules incorporating structured learning supports significantly improved learners' metacognitive awareness and self-monitoring skills.

Table 22 presents the learners' metacognition in terms of *Regulation of Cognition* before and after exposure to the SDLE modules. Before the intervention, 46.3% of the learners were classified as *Moderately Evident*, 32.5% as Evident, and 8.8% as *Highly Evident.* After the intervention, the percentage of learners at the *Evident* level increased substantially to 56.3%, while those classified as *Moderately Evident* decreased to 28.8%. Furthermore, the proportion of learners categorized as *Highly Evident* increased from 8.8% to 12.5%, and those at the *Least Evident* level decreased from 12.5% to only 2.5%.

Table 22. *Metacognition in Terms of Regulation of Cognition of Grade 9 Learners Before and After Using the SDLE Modules*

Level of Metacognition	Pre-Intervention		Post-Intervention	
	Freq.	%	Freq.	%
Highly Evident	7	8.8%	10	12.5%
Evident	26	32.5%	45	56.3%
Moderately Evident	37	46.3%	23	28.8%
Least Evident	10	12.5%	2	2.5%
Very Least Evident	-	-	-	-

The Wilcoxon Signed-Rank Test results shown in Table 23 confirmed the statistical significance of these changes.

Table 23**.** *Median Regulation of Cognition Scores Before and After the Use of SDLE Modules*

Pre-test	Post-test	T	Z	p	Decision	Interpretation
3.28 (0.59)	3.64 (0.55)	10.00	-7.58	.000	Reject H_0	Significant Difference

The median Regulation of Cognition score increased from *3.28 (SD = 0.59)* before the intervention to *3.64 (SD = 0.55)* after the intervention. The computed values of *T = 10.00, Z = -7.58, and p = .000* led to the rejection of the null hypothesis, indicating a *significant difference* between the pre-intervention and post-intervention scores. This finding suggests that the SDLE modules enhanced learners' ability to plan, monitor, manage information, employ debugging strategies, and evaluate their own learning. The result is consistent with the findings of Jones (2022), Smith (2024), and Wilson (2024), who found that digital learning environments incorporating reflective tasks, formative assessments, and metacognitive prompts significantly improved learners' self-regulation and metacognitive control. Moreover, Saguna and Prudente (2023) and Padios (2023) reported that science learning environments designed around metacognitive principles foster stronger learner autonomy and higher levels of cognitive engagement.

Overall, the findings demonstrate that implementing the SDLE modules led to statistically significant improvements in both *science achievement* and *metacognition* among Grade 9 learners. The intervention not only increased learners' academic performance, as evidenced by a substantial shift toward higher achievement levels, but also strengthened both dimensions of metacognition—knowledge of cognition and regulation of cognition. The consistent rejection of the null hypothesis across all three outcome variables confirms the effectiveness of the SDLE as an instructional innovation. These findings provide empirical support for the use of structured digital learning environments to enhance both cognitive and metacognitive outcomes in science education.

Summary

This study employed a Research and Development (R&D) design consisting of four phases: (1) descriptive survey, (2) developmental research, (3) descriptive-evaluative research, and (4) one-group pretest-posttest implementation. Quantitative data were obtained from science teachers, science experts, and Grade 9 learners, while qualitative data were gathered through open-ended responses subjected to thematic analysis. The developed Structured Digital Learning Episodes (SDLEs) were validated by science teachers and subject-matter experts and subsequently implemented with Grade 9 learners. Data were analyzed using weighted mean, grand mean, rank, frequency, percentage, mean, standard deviation, Shapiro-Wilk Test, and Wilcoxon Signed-Rank Test.

The salient findings of the study are the following.

1. **On the Extent of Utilization of Structured Digital Learning Episodes.** Science teachers reported a grand mean of 3.52, interpreted as Utilized. The highest-rated indicator was the use of technology-assisted instructional strategies to introduce new science concepts (M = 3.69), followed by their use in assessment activities (M = 3.67). The lowest-rated indicator was the integration of these strategies into weekly lesson plans (M = 3.22).
2. **On the Challenges Encountered by Science Teachers in Using Structured Digital Learning Episodes.** The overall assessment yielded a grand mean of 4.08, interpreted as Challenging. The highest-rated challenge was the lack of appropriate devices (M = 4.31), followed by limited access to stable internet connectivity (M = 4.25) and difficulty in designing technology-assisted instructional strategies for complex science topics (M = 4.25). Thematic analysis generated three themes: Adaptive Strategies in Addressing SDLE Implementation Challenges, Teacher Capacity Development, and Resources and Institutional Support.
3. **On the Development of Structured Digital Learning Episodes.** Based on the findings of the needs assessment and thematic analysis, Structured Digital Learning Episodes (SDLE) for Grade 9 Science were developed. The modules were designed to include curriculum-aligned objectives, digital learning content, guided learning activities, embedded formative assessments, reflection tasks, multimedia resources, and navigation features intended to support technology-assisted science learning.
4. **On the Acceptability of the Structured Digital Learning Episodes.** The developed SDLE modules obtained an overall composite mean of 4.49, interpreted as Highly Acceptable. Among the criteria, Organization received the highest rating (M = 4.59), followed by Evaluation (M = 4.53) and Objectives (M = 4.52). The lowest-rated criterion was Language and Style (M = 4.39), which remained within the Highly Acceptable category. Science teachers obtained an overall mean of 4.32, while science experts obtained 4.66, both interpreted as Highly Acceptable.
5. **On the Difference in Grade 9 Learners' Science Achievement and Metacognition Before and**

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After Using the SDLE. In science achievement, the percentage of learners classified as Very Satisfactory increased from 26.3% during the pre-intervention phase to 55.0% during the post-intervention phase, while 17.5% attained the Outstanding level after the implementation of the SDLE. The median achievement score increased from 13.49 to 20.83. The Wilcoxon Signed-Rank Test yielded $T = 43.00$, $Z = -7.53$, and $p = .000$.

For metacognition in terms of Knowledge of Cognition, the proportion of learners classified as Evident increased from 22.5% before the intervention to 65.0% after the intervention. The median score increased from 3.21 to 3.58, with a Wilcoxon Signed-Rank Test result of $T = 47.50$, $Z = -7.23$, and $p = .000$.

For metacognition in terms of Regulation of Cognition, learners classified as Evident increased from 32.5% before the intervention to 56.3% after the intervention. The median score increased from 3.28 to 3.64, with a Wilcoxon Signed-Rank Test result of $T = 10.00$, $Z = -7.58$, and $p = .000$.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

1. Science teachers in District VI, Division of the City of Manila generally utilize Structured Digital Learning Episodes through technology-assisted instructional strategies in teaching Grade 9 Science, particularly for concept introduction, assessment, learner engagement, and curriculum alignment, indicating that digital instructional approaches have become an integral component of science instruction.
2. The implementation of Structured Digital Learning Episodes is influenced by challenges related to technological resources, teacher preparedness, learner readiness, and institutional support, demonstrating that successful integration of digital learning requires both individual and systemic enabling conditions.
3. The identified instructional practices and implementation challenges provided a sound empirical basis for the development of Structured Digital Learning Episodes that are responsive to the instructional needs of Grade 9 Science teachers and learners.
4. The developed Structured Digital Learning Episodes are highly acceptable to both science teachers and science experts in terms of objectives, content, activities, usefulness, language and style, organization, presentation, evaluation, and navigation, indicating their suitability for instructional use in Grade 9 Science.
5. The use of Structured Digital Learning Episodes effectively enhances Grade 9 learners' science achievement and metacognition, as evidenced by significant improvements in science achievement, knowledge of cognition, and regulation of cognition following exposure to the intervention.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are offered:

1. Science teachers. Science teachers may integrate the developed 'Science Metacognition Through Structured Digital Learning Episodes' modules into their regular classroom instruction by incorporating structured digital learning activities into lesson planning, instruction, assessment, and remediation. Teachers may also adapt the design principles of the SDLE in developing similar digital instructional materials for other science topics and grade levels.
2. School administrators. School administrators may provide adequate technological resources, reliable internet access, and institutional support mechanisms to address the challenges encountered in the implementation of Structured Digital Learning Episodes. They may also facilitate professional development programs focusing on digital pedagogy, instructional design, and technology integration to enhance teachers' competence and confidence in using the SDLE.
3. Curriculum specialists and curriculum planners. Curriculum specialists and curriculum planners

may utilize the findings of the needs assessment and thematic analysis as a basis for designing and refining digital learning materials that are responsive to the needs of teachers and learners. They may also incorporate the SDLE into the division's supplementary instructional materials and provide guidance on its effective integration with the K to 12 Science Curriculum.

4. Schools and educational institutions may adopt and implement the developed Structured Digital Learning Episodes as supplementary instructional materials in Grade 9 Science classes. Prior to large-scale implementation, orientation and capacity-building activities may be conducted to ensure effective utilization of the modules by both teachers and learners.
5. Research developers. Research developers may build upon the findings of this study by conducting further investigations on the effectiveness of Structured Digital Learning Episodes in other subject areas, grade levels, and educational contexts. They may also explore the integration of emerging technologies such as artificial intelligence and adaptive learning systems into the SDLE design.
6. Future researchers. Future researchers may conduct similar studies involving larger samples, different grade levels, subject areas, and educational settings to further validate the effectiveness of Structured Digital Learning Episodes. Future investigations may likewise explore their impact on other learner outcomes such as scientific inquiry skills, critical thinking, self-regulated learning, motivation, engagement, and digital literacy using experimental, mixed-methods, or longitudinal research designs.

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