International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

Effectiveness of cognitive load management strategies in enhancing comprehension and retention in Science among Grade 7 learners

Kimberly L. Alangcao
University of Saint Anthony, Iriga City
Corresponding Author email: *kimalangcao@gmail.com*

Received: 24 March 2026 **Revised**: 06 May 2026 **Accepted**: 12 May 2026

Available Online: 14 May 2026

Volume 1 (2026), Issue 2, P-ISSN – 3116-3769; E-ISSN - 3116-3777

https://doi.org/10.63498/injelps64

Abstract

Aim: This study examined the cognitive load challenges encountered by Grade 7 learners in science, the strategies they employ to manage these challenges, and the effects of these strategies on their comprehension, retention, and retrieval of scientific concepts. It also aimed to develop and validate an instructional material grounded in cognitive load principles to support science learning.

Methodology: A descriptive mixed-method research design was utilized involving 60 Grade 7 learners from Cristo Rey Integrated School during the School Year 2025–2026. Data were gathered through survey questionnaires and focus group discussions to analyze learners' cognitive load experiences, coping strategies, and perceived learning outcomes.

Results: Findings revealed that learners experience significant cognitive load challenges, particularly in understanding complex scientific terms, managing large volumes of information, and processing multiple concepts simultaneously. Learners frequently use basic strategies such as note-taking, highlighting, and active participation, while higher-order metacognitive strategies are less consistently applied. Despite this, learners reported positive effects of these strategies on comprehension, retention, and retrieval. Based on these findings, Cognitive Learning Enhancement Activity Resource (C.L.E.A.R. Science), a cognitive load–based activity guide, was developed and obtained high ratings in terms of content quality, organization, and accuracy during curricular validation.

Conclusion: The study confirms that unmanaged cognitive load hinders effective science learning, while structured cognitive load management strategies significantly enhance learners' understanding, long-term retention, and recall of scientific concepts. The findings highlight the need for teachers to explicitly integrate cognitive load–based strategies and scaffold higher-order metacognitive skills in instruction. The validated C.L.E.A.R. Science Activity Guide provides a research-based instructional resource that can support improved teaching practices, curriculum implementation, and learner outcomes in science education.

Keywords: *cognitive load theory, cognitive load management strategies, science education, instructional materials, comprehension and retention*

INTRODUCTION

The human brain is a highly sophisticated organ, characterized by a complex network of billions of neurons that collaborate to facilitate cognition, learning, and memory (Baxter et al., 2025). However, despite its vast capabilities, the brain has its limits. Imagine pouring water into a glass; if you pour too much, it overflows. In the same way, when too much information is presented at once, the brain might struggle to keep up. This phenomenon is known as cognitive load, which is defined as the mental effort needed to process and store new information (Sweller, 2024). If this load is too high, learning becomes difficult, and important details may be forgotten. This is particularly important in subjects that require deep understanding and problem-solving, such as science education. Contemporary research emphasizes that while structured and scaffolded metacognitive instruction can align with cognitive capacities, certain self-regulatory tasks may inadvertently increase mental load, potentially suppressing learning gains if not carefully integrated across longer instructional process (Hartelt et al., 2024). These findings highlight the growing importance of designing instruction that aligns with the cognitive architecture of learners.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

Science education is one of the most essential foundations of lifelong learning , equipping learners with the essential scientific literacy required to navigate an increasingly complex world (Sjöström, 2024). However, as scientific knowledge rapidly expands, learners are expected to keep up with the increasingly complex concepts. Globally, studies reveal that meaningful science learning depends on the ability of learners to process, retain, and apply science concepts. When instruction fails to manage cognitive load effectively, learners are at risk of confusion, misconceptions, and poor retention.

In the Philippines, the Department of Education (DepEd) emphasizes the importance of improving science education through innovative teaching methods. This commitment is rooted in national policy and law. The Republic Act 10533, or the Enhanced Basic Education Act of 2013, mandates a learner-centered curriculum that develops problem-solving and critical thinking skills. This is further supported by DepEd Order No. 21, s. 2019, specifically provides policy guidelines for the K to 12 programs, emphasizing the development of 21st-century skills like scientific literacy through meaningful, context-based instruction. Despite these policy frameworks, the 2022 Programme for International Student Assessment (PISA) results revealed that Filipino students ranked among the lowest globally, with an average score of 356 in science and ranking in the bottom four out of 64 countries in creative thinking, with an average score of 14 which significantly below the Organization for Economic Cooperation and Development (OECD) average of 33. These results indicate that Filipino learners continue to perform below international benchmarks in science literacy and creative thinking, suggesting that although curriculum reforms have been implemented, instructional approaches may still need stronger alignment with learners' cognitive needs and learning capacities.

Recently, the Department of Education introduced the Revised Kindergarten to Grade 10 (K to 10) Curriculum (DepEd Order No. 004, s. 2024), which aims to decongest content, focus on essential learning competencies, and ensure alignment with learners' developmental stages. However, despite these efforts, learners continue to face a difficult transition as they encounter the depth and complexity of core subjects such as science. Based on classroom observations, many learners showed frustration and disengagement when lessons became too heavy, often relying on rote memorization rather than developing deeper conceptual understanding. This suggests that the problem does not lie solely in the content itself but also in how it is delivered, which may either lessen or intensify cognitive demands. Supporting these observations, recent studies in resource-constrained educational settings suggest that learners experience greater difficulty in maintaining attention, processing information, and retrieving learned concepts when instruction does not adequately address cognitive limitations (Orbeta, 2022).

Moreover, unavoidable circumstances such as natural disasters, extreme heat, and other disruptions that are common in the Philippine context have led to the increased use of Alternative Delivery Modes (ADM), where learners engage in self-paced modular learning. While ADM ensures continuity of education, recent studies indicate that independent learning environments may increase learners' cognitive demands, particularly when instructional guidance is limited or learning materials are not cognitively optimized (Le Cunff et al., 2024). This places greater cognitive demands on learners who must process information independently with minimal teacher guidance, thereby increasing the risk of cognitive overload.

Given these challenges, there is a critical need to examine how cognitive load can be effectively managed in real classroom contexts, particularly among junior high school learners in the Philippines. While previous studies have explored cognitive load theory in higher education and technology-rich environments, limited research has focused on its practical application in Grade 7 science classrooms, especially in resource-constrained settings. Moreover, few studies have integrated learners' cognitive challenges, coping strategies, and learning outcomes with the development of instructional materials.

Addressing this gap, the present study investigates the cognitive load challenges experienced by Grade 7 learners, the strategies they employ, and the effects of these strategies on comprehension, retention, and retrieval of scientific concepts. It further contributes to educational practice by developing and validating a Cognitive Load–Based Activity Guide (C.L.E.A.R. Science), offering an innovative, research-based instructional resource to support teachers, enhance curriculum implementation, and improve science learning outcomes.

Review of Related Literature and Studies

Critical role of instructional design in managing cognitive load

Instructional design plays a crucial role in managing cognitive load and facilitating effective learning. Liu (2024) emphasized that segmenting content into smaller, more manageable parts reduces cognitive load, enhances learning efficiency, and improves retention, particularly in digital learning environments. This supports the argument that structured delivery of information prevents cognitive overload and promotes deeper understanding. Similarly,

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

Mayer and Fiorella (2021) introduced the segmenting principle, which posits that breaking complex materials into learner-paced steps allows more efficient processing and transfer of information into long-term memory. Supporting this, Sozio et al. (2024) found that worked examples, particularly when designed to emphasize either learning processes or final products, significantly improve instructional effectiveness by reducing unnecessary cognitive load and helping learners focus on essential problem-solving strategies. Their findings further reinforce the importance of carefully designed instructional materials in promoting meaningful learning.

In the Philippine context, Delos Santos and Fiscal (2024) found that active learning strategies, such as cooperative learning and real-world problem-solving, significantly enhance student engagement and comprehension in science education. Furthermore, Orbeta (2022) highlighted that Instructional Message Design reduces cognitive resource expenditure and promotes creative thinking through structured content and appropriate teaching strategies. These studies establish that well-planned instructional design grounded in Cognitive Load Theory (CLT) is essential for optimizing cognitive processing, engagement, and learning outcomes, which directly supports the focus of the present study.

Used of multimedia in managing cognitive load

Multimedia integration has been widely recognized as an effective approach in managing cognitive load when properly designed. Castro-Alonso, de Koning, Fiorella, and Paas (2021) identified key strategies—such as the multimedia principle, spatial contiguity, redundancy reduction, signaling, and segmentation—that help optimize cognitive processing. These principles demonstrate that multimedia can either enhance or hinder learning depending on its design, thereby reinforcing the need for careful instructional planning.

In the Philippine setting, Del Mundo and Caballes (2022) found that students who used Interactive Strategic Instructional Materials (I-SIM) experienced above-average cognitive load but still showed improved post-test performance. This suggests that increased cognitive load is not necessarily detrimental when it contributes to meaningful learning. Similarly, Alarcon (2025) reported that multimedia integration enhances student engagement and conceptual retention. These findings support the argument that well-designed multimedia materials can balance cognitive demands while promoting deeper understanding, making them valuable tools in science education and relevant to the current study's emphasis on cognitive load management.

Well-structured tasks aligned with cognitive abilities and differences

Designing tasks that align with learners' cognitive capacities is essential for effective learning. Lopez (2024) demonstrated that microlearning modules optimized for cognitive engagement promote higher germane load and improved knowledge retention, highlighting the importance of aligning instructional tasks with learners' processing abilities. This is further supported by Mangubat and Paglinawan (2024), who found that task complexity in science is directly proportional to students' cognitive load. Their findings emphasize that poorly structured tasks can overwhelm learners and hinder comprehension, thereby underscoring the importance of task design in cognitive load management.

In the Philippine context, Abeysekera, Sunga, Gonsales, and David (2024) revealed that students who effectively managed cognitive load achieved better retention, pointing to the significance of quality instruction, well-designed content, and user-friendly learning management systems. Similarly, Estacio et al. (2022) found that graphic organizers improve both cognitive load management and knowledge retention, supporting the use of scaffolding strategies. Moreover, Capundan (2025) observed that although Grade 7 students exhibited high cognitive load and metacognitive awareness, their learning outcomes remained mocostderate, suggesting a mismatch between task demands and instructional support.

In addition, recent studies highlight that systemic challenges in the Philippine educational system affect teachers' instructional practices and may limit their capacity to effectively scaffold learning, which can contribute to increased cognitive demands among learners in science (Frianeza, E. D. et al., 2024). Furthermore, Ilumin, R. A. et al. (2025) reported that students transitioning to junior high school rely on strategies such as guidance-seeking, note-taking, and peer instruction to cope with increased cognitive demands, highlighting the need for varied and adaptive teaching approaches. Furthermore, Fuentes and Chua (2025) confirmed that Cognitive Load-Based Strategic Intervention Materials (SIMs) significantly enhance comprehension and basic science skills. These studies collectively demonstrate that structured instructional strategies, scaffolding techniques, and Cognitive Load Theory (CLT)-based materials are essential in promoting comprehension, retention, and active learning, directly supporting the framework of the present study.

Collectively, the literature consistently indicates that effective cognitive load management supports learning efficiency, comprehension, and retention. Foreign studies collectively support the principles of CLT in various

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

educational settings, while local studies demonstrate the applicability and challenges of these strategies in Philippine classrooms. This study was built on prior research by investigating how cognitive load management strategies affect comprehension, retention, and retrieval among Grade 7 Science students in a Philippine school, particularly in designing instructional approaches that balance engagement with cognitive efficiency.

Overall, the literature converges on three points: (1) cognitive load critically influences learning; (2) well-designed instruction reduces extraneous load and supports comprehension and retention; and (3) instructional strategies must align with learners' cognitive capacities and context. However, most prior studies focus on higher education or technology-rich environments, whereas few examine how junior high learners in Philippine schools personally experience and manage cognitive load. Building on these insights, the present study investigated how cognitive load management strategies affect comprehension, retention, and retrieval among Grade 7 science learners, emphasizing instructional approaches that balance cognitive efficiency with engagement.

Theoretical Framework

The study was anchored in Cognitive Load Theory (CLT), coined in 1988 by John Sweller, which explains how the brain processes information during learning. According to Sweller (1988), the human mind has a limited working memory capacity, and if this capacity is overloaded, learning becomes difficult. CLT has three types of cognitive load: intrinsic load (the complexity of the material itself), extraneous load (unnecessary mental effort caused by poor instructional design), and germane load (the mental effort devoted to building long-term knowledge structures). By understanding these cognitive loads, teachers can design strategies that minimize extraneous load and optimize germane load, which make it easier for students to process and retain new information. This theory is especially relevant in science education because scientific concepts can be complex and difficult to grasp.

Complementing this is the Information Processing Theory (Atkinson & Shiffrin, 1968), which explains how information is received, encoded, stored, and retrieved in the human mind. This model compares the human brain to a computer that processes information through three major memory systems: sensory memory, short-term memory, and long-term memory. For information to move from one stage to another, it requires attention, rehearsal, and meaningful connection. In this study, the principles of information processing were applied in sequencing learning activities, structuring tasks, and reinforcing learned concepts to help students retain and retrieve knowledge effectively. By considering how learners encode and store information, instructional material was developed to enhance recall, promote comprehension, and prevent cognitive overload during science instruction.

The Constructivist Theory (Piaget, 1964) further strengthens the framework by emphasizing that learning is an active and constructive process. Piaget argued that learners build knowledge based on their experiences and prior understanding. Through assimilation and accommodation, learners form new schemas or modify existing ones to make sense of new information. In the context of this study, the constructivist approach inspired the inclusion of hands-on, reflective, and inquiry-based activities that encourage learners to explore, question, and derive meaning from what they discover. This theory underscores the importance of learner-centered strategies that enable students to take an active role in constructing their understanding of scientific concepts, rather than passively receiving information.

Conceptual Framework

The conceptual framework of this study followed an Input–Process–Output (IPO) structure. Figure 1 illustrates how the study moved from identifying learner needs to developing and validating instructional materials that address the cognitive demands of Grade 7 Science.

The input focuses on the cognitive load challenges experienced by Grade 7 learners in science, including the difficulties encountered in processing complex concepts and information. It also includes the cognitive load management strategies employed by learners, as well as variables that explain how these strategies influence comprehension, retention, and retrieval. These inputs collectively represent the learners' experiences and serve as the basis for designing appropriate instructional support.

The process involves the presentation, analysis, and interpretation of data gathered through survey questionnaires and focus group discussions. Guided by the results, a cognitive load-based instructional material in the form of an activity guide was developed. This material then underwent expert validation using the Department of Education Learning Resource Management and Development System (DepEd LRMDS) evaluation tool, focusing on content quality, organization, accuracy, alignment with learning competencies, and its effectiveness in supporting and enhancing science learning. Revisions were made based on expert feedback to ensure that the material is both theoretically grounded and responsive to learners' needs.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

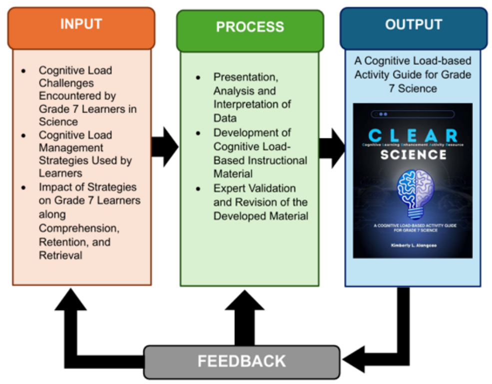

Figure 1. Research Paradigm

The output of the framework is the developed instructional material known as C.L.E.A.R. (Cognitive Learning Enhancement Activity Resource), a structured activity guide designed for Grade 7 Science. It integrates cognitive load management strategies to enhance learners' understanding and long-term retention of scientific concepts. Additionally, it serves as a supplementary resource for teachers to support more effective instruction.

A feedback mechanism links the output back to the input and process, allowing continuous refinement of the instructional material. Insights from evaluation and validation ensure ongoing improvement and adaptability to learners' needs and instructional contexts. Overall, the framework illustrates how understanding learner challenges, applying appropriate strategies, and validating instructional materials contribute to improved learning performance and conceptual mastery in Science learning.

Statement of the Problem

This study investigates the cognitive load challenges encountered by Grade 7 learners in science, the strategies they employ to manage these challenges, and the impact of these strategies on their learning. Cognitive Load Theory emphasizes that managing intrinsic, extraneous, and germane cognitive load is essential for effective learning, while existing local and international studies indicate that instructional design, learner strategies, and contextual factors significantly influence how students cope with cognitive demands.

Despite these insights, junior high school learners in the Philippines continue to experience difficulties in processing complex scientific concepts, technical terms, and large volumes of information during science instruction. These challenges often result in cognitive overload, limited comprehension, and reduced retention of learning. Furthermore, there is limited research that integrates learners' cognitive load experiences, their management strategies, and the development of instructional materials tailored to their needs, particularly in resource-constrained contexts.

Addressing these gaps is essential for designing effective instructional interventions that enhance comprehension, retention, and retrieval of scientific concepts. Hence, this study seeks to examine learners' cognitive load challenges, identify the strategies they employ, determine the impact of these strategies on learning outcomes, and develop a validated instructional material to support improved science learning.

Research Objectives

General Objective

To investigate the cognitive load challenges of Grade 7 learners in science, the strategies they use to manage these challenges, and the impact of these strategies on their learning outcomes.

Specific Objectives

1. To identify the common cognitive load challenges encountered by Grade 7 learners in science.
2. To explore the cognitive load management strategies employed by Grade 7 learners in science.
3. To determine the impact of cognitive load management strategies on learners' comprehension, retention, and retrieval of scientific concepts.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

4. To develop instructional materials based on the findings of the study.
5. To assess the quality, accuracy, and effectiveness of the developed instructional materials through curricular validation.

Research Questions

1. What cognitive load challenges are encountered by Grade 7 learners in science?
2. What cognitive load management strategies are employed by Grade 7 learners in science?
3. What is the impact of cognitive load management strategies on learners':
   a. comprehension,
   b. retention, and
   c. retrieval of scientific concepts?
4. What instructional material can be developed based on the findings of the study?
5. What are the results of the curricular validation of the developed instructional material?

METHODS

Research Design

This study employed a descriptive mixed-method research design to systematically identify and analyze the cognitive load challenges encountered by Grade 7 learners in science, as well as the strategies they use to manage cognitive load and their impact on learning. The descriptive approach enabled the researcher to examine and interpret learners' experiences and behaviors without manipulating variables, providing an accurate representation of their current learning conditions. The quantitative component, through survey questionnaires, gathered measurable data on learners' cognitive load challenges and management strategies. In contrast, the qualitative component, through focus group discussions, provided in-depth insights into learners' experiences, perceptions, and coping mechanisms. These two components complemented each other by allowing statistical trends to be explained and enriched through detailed narratives, ensuring a more comprehensive understanding of the phenomenon.

Furthermore, the findings from this mixed-method descriptive phase served as the basis for the design, development, and refinement of instructional materials aligned with cognitive load management principles. The developed material was then subjected to curricular validation by subject-matter experts using the Department of Education Learning Resource Management and Development System (LRMDS), a standardized evaluation framework used in Philippine basic education for assessing the quality, relevance, and instructional suitability of learning resources. This process ensured the material's accuracy, clarity, appropriateness, and effectiveness in supporting science learning.

Population and Sampling

A total of 60 Grade 7 learners enrolled in Cristo Rey Integrated School were included as primary participants in identifying cognitive load challenges and the strategies they use in learning Science. The study employed total population sampling, as all Grade 7 learners were included to ensure a comprehensive representation of the group. In addition, ten (10) Science teachers and curriculum experts were purposively selected as validators of the developed instructional material due to their expertise in content evaluation, ensuring its accuracy, clarity, instructional alignment, and effectiveness.

Instruments

The study employed two primary data-gathering instruments: a researcher-developed survey questionnaire and a focus group discussion (FGD) interview guide. The survey questionnaire, grounded in Cognitive Load Theory (Sweller, 1988) and related literature, served as the main quantitative tool and was composed of three sections addressing learners' cognitive load challenges, their management strategies, and the perceived effects of these strategies on comprehension, retention, and retrieval of scientific concepts. It underwent expert validation by the thesis adviser and a dry run with ten non-participant learners to ensure clarity, reliability, and appropriateness before administration. To complement the quantitative data, the FGD interview guide was used to gather qualitative data through open-ended questions, allowing ten Grade 7 learners to share detailed experiences and insights.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

Data Collection

Prior to data collection, approval was secured from the Schools Division Superintendent of Schools Division Office (SDO) of Iriga City and the School Head of Cristo Rey Integrated School. Upon approval, the survey questionnaire was administered to the respondents in accordance with the Department of Education's Time-on-Task policy, which ensures that data collection activities do not interfere with allotted instructional time or disrupt regular classroom learning. Completed questionnaires were immediately retrieved to ensure confidentiality and prevent response contamination. The collected data were then tallied, tabulated, and analyzed, with results cross-checked and validated by the thesis adviser to ensure accuracy and integrity.

The focus group discussion (FGD) was conducted to complement and validate the quantitative findings. It involved ten Grade 7 learners and utilized open-ended questions to elicit in-depth responses regarding their cognitive load challenges, management strategies, and learning experiences. The discussion was conducted in a small-group setting, with responses recorded upon consent and subsequently transcribed for thematic analysis. The qualitative data provided deeper insights and supported the interpretation of the survey results.

Treatment of Data

Frequency count, and average weighted mean were used to quantify the cognitive load challenges experienced by Grade 7 learners, the strategies they employed, and the perceived effects on their comprehension, retention, and retrieval in Science. These statistical tools were appropriate for analyzing Likert-scale responses, allowing for clear and systematic interpretation of the data. For the qualitative data from the focus group discussion (FGD), thematic analysis was applied by transcribing responses, coding significant statements, grouping similar codes into categories, and generating themes that represent learners' experiences. These themes were then used to support and explain the quantitative findings, providing a more comprehensive understanding of the results.

Ethical Considerations

The study strictly adhered to established ethical guidelines to protect the rights, privacy, and welfare of all respondents, with informed consent obtained prior to data collection and approval secured from the division and school administration. Participants were fully informed about the purpose, procedures, and voluntary nature of the study, including their right to withdraw at any time without consequences. Confidentiality and anonymity were ensured through the use of coded identifiers in place of names, while all collected data were securely stored in password-protected digital files and kept in a locked storage device accessible only to the researcher and thesis adviser. Data will be retained for a specified period and properly disposed of after the completion of the study.

RESULTS and DISCUSSION

1. **Cognitive Load Challenges Experienced by Grade 7 Learners in Science**

Grade 7 learners are in a transition stage from elementary to junior high school, requiring them to adjust to more complex content, structured learning demands, and higher levels of scientific reasoning. This study examined the cognitive load challenges they experience to understand how these demands affect their learning in Science.

Table 1 presents the results of the cognitive load challenges encountered by Grade 7 learners in science, highlighting which aspects of science lessons tend to overwhelm learners' cognitive capacity. The weighted mean scores for all indicators ranged from 2.9 to 3.77, with an overall average of 3.42, suggesting that learners generally agree they experience cognitive load–related difficulties in their science classes.

The most pressing challenges were dealing with complex or technical terms, which obtained the highest score of 3.77, followed by difficulty retaining information when too much content is presented and struggles when multiple concepts are introduced at once, both rated at 3.68. These findings indicate that learners are most burdened by the inherent complexity and density of science content, pointing to the influence of intrinsic cognitive load. Other challenges that were strongly noted which suggest that both the pace of instruction and the manner of delivery intensify students' cognitive load, creating pressure not only from the volume of content but also from how it is presented and processed. The Focus Group Discussion (FGD) also provided qualitative insights that support and elaborate on the survey findings. Learners shared that unfamiliar words and technical terms often make science concepts hard to grasp, while fast-paced instruction and being unprepared for recitation cause stress and anxiety. Some learners reported difficulty maintaining focus, especially when lessons are uninteresting or information is too dense to process. Many described that science concepts sometimes feel confusing, which makes them nervous about participating in class. At the same time, a few learners indicated that they could manage and follow lessons without

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

major difficulty, which explains why some survey items were rated neutral. These findings are consistent with recent studies on cognitive load and student learning experiences.

Table 1
Survey Result of Cognitive Load Challenges Encountered by Grade 7 Learners in Science

Indicators/ Cognitive Load Challenges	WM	VI
1. Difficulty with complex or technical terms	3.77	Agree
2. Struggles in problem-solving or experiments	3.42	Agree
3. Feels confused during science lessons	3.20	Neutral
4. Too much information to remember	3.48	Agree
5. Unclear examples or instructions	2.90	Neutral
6. Difficulty focusing due to distractions	3.45	Agree
7. Overwhelmed by long texts	3.58	Agree
8. Easily forgets science concepts	3.12	Neutral
9. Confused by visuals or diagrams	3.02	Neutral
10. Experiences stress/anxiety when failing to understand	3.58	Agree
11. Difficulty when multiple concepts are introduced at once	3.68	Agree
12. Gets lost when topics shift suddenly	3.65	Agree
13. Struggles to apply previous lessons	3.25	Neutral
14. Confused when teachers speak too fast	3.57	Agree
15. Mentally tired during discussions	3.60	Agree
16. Difficulty retaining when too much information is given	3.68	Agree
17. Doesn't understand activity/worksheet instructions	2.95	Neutral
18. Frustrated by low scores despite effort	3.57	Agree
19. Doesn't understand questions in science tasks	3.50	Agree
20. Overloaded by science videos with too much information	3.33	Neutral
Average Weighted Mean	3.42	Agree

These findings are consistent with recent studies on cognitive load and student learning experiences. Le Cunff et al. (2024), through focus group discussions, found that students often experience confusion, difficulty processing instructional content, and increased cognitive burden when learning materials are not clearly organized, which negatively affects engagement and comprehension. Similarly, Tim Hartelt and Martens (2024) reported that students' self-efficacy and classroom participation may decline when instructional tasks require high mental effort, especially when learners feel uncertain about their understanding of scientific concepts.

The results imply that effective instructional design should focus on reducing unnecessary cognitive demands while strengthening meaningful processing. For teachers, this highlights the importance of simplifying technical language, pacing lessons appropriately, and scaffolding complex concepts. For school leaders, there is a need to support instructional supervision practices that promote cognitive load–aware teaching strategies. Curriculum developers may consider reviewing the density and sequencing of Science competencies to ensure developmental appropriateness, while policymakers may strengthen guidelines that promote learner-centered and cognitively appropriate instructional design in science education. In addition, teacher education programs should integrate training on Cognitive Load Theory and instructional design strategies to better prepare pre-service teachers in managing learner cognition effectively.

2. Cognitive Load Management Strategies Employed by Grade 7 Learners in Science

Table 2 presents the cognitive load management strategies employed by Grade 7 learners in science. The weighted mean scores ranged from 3.05 to 4.08, with an overall average of 3.60, indicating that learners often use a variety of strategies to manage cognitive load during science learning.

The most frequently employed strategies were taking notes during videos or explanations (4.08), actively participating and reflecting during hands-on or simulation activities (4.07), and highlighting or underlining key points (4.02) which are all verbally interpreted as Always. These results suggest that learners rely heavily on foundational yet essential strategies that support attention, immediate processing, and working-memory reinforcement. Such behaviors indicate active engagement and awareness of how to cope with dense or challenging science content. Meanwhile, several indicators fell under the Sometimes category which imply that although learners practice essential

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

strategies, they are less consistent in using more advanced metacognitive and organizational techniques that support deeper learning, long-term retention, and efficient management of cognitive load.

Table 2
Survey Result of the Cognitive Load Management Strategies Employed by Grade 7 Learners in Science

Indicators/Cognitive Load Management Strategies	WM	VI
1. Break topics into smaller parts	3.52	Often
2. Use diagrams/drawings to remember/visualize concepts	3.40	Often
3. Ask questions/seek help when confused	3.83	Often
4. Connect new lessons to prior knowledge	3.52	Often
5. Review notes regularly	3.87	Often
6. Focus/avoid distractions in class	3.87	Often
7. Use keywords or mnemonics	3.85	Often
8. Discuss topics with classmates	3.48	Often
9. Watch videos or use apps	3.17	Sometimes
10. Actively participate and reflect during hands-on activities	4.07	Always
11. Summarize lessons in own words	3.32	Sometimes
12. Create outlines or concept maps	3.35	Sometimes
13. Focus on main ideas before details	3.53	Often
14. Reread difficult parts of the text	3.77	Often
15. Take short breaks while studying	3.48	Often
16. Ask teacher to explain again	3.68	Often
17. Take notes during videos/explanations	4.08	Always
18. Highlight/underline key points	4.02	Always
19. Adjust study habits for difficult topics	3.22	Sometimes
20. Plan study time and study lessons ahead of time.	3.05	Sometimes
Average Weighted Mean	**3.60**	**Often**

The Focus Group Discussion provided additional qualitative insights, showing that learners learn best through hands-on activities and practical engagement. Other strategies mentioned included watching instructional videos (YouTube), taking notes, seeking clarification from teachers or AI tools, self-review, maintaining focus, and collaborative activities. Learners also suggested instructional support strategies such as clearer explanations, more concrete examples, the use of games and experiments, translation to the mother tongue, and collaborative learning activities. These FGD responses align with survey findings, emphasizing that active participation, note-taking, visual support, and teacher guidance are essential for managing cognitive load effectively. They also reflect learners' awareness of instructional strategies that can further strengthen their understanding, support long-term learning, and improve their ability to recall scientific concepts when needed. The results align with Delos Santos and Fiscal (2024), who emphasized that practical, activity-based learning enhances comprehension by promoting germane cognitive load.

The findings indicate that while Grade 7 learners actively use basic cognitive load management strategies, there is limited and inconsistent use of advanced metacognitive strategies. This implies a need for explicit instruction in summarizing, organizing information, concept mapping, and study planning to strengthen learners' self-regulated learning skills. For teachers, this highlights the importance of scaffolding strategy instruction rather than only content delivery. For curriculum designers and school leaders, the findings suggest integrating structured learning strategy development into Science instruction to support not only content mastery but also learners' capacity to manage cognitive load effectively for improved comprehension, retention, and retrieval.

3. Impact of Cognitive Load Management Strategies on Science Learning

Learning science often challenges students to process science concepts while retaining and applying knowledge effectively. This reflects the inherent demands of science learning, which requires learners to integrate prior knowledge with new information while engaging in higher-order thinking processes such as analysis, comprehension, and application. Table 3 displays learners' perceptions of strategies that may influence how they understand, remember, and use Science lessons. The data highlight patterns in learners' experiences that support meaningful learning and confidence in scientific content.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

Table 3
Survey Result of the Impact of Cognitive Load Management Strategies on Grade 7 with Science Learning along Comprehension, Retention and Retrieval

Indicators	WM	VI
Comprehension		
1. Strategies help learners clearly understand main ideas of science lessons.	4.05	Agree
2. Learners can explain Science lessons in their own words after using the strategies.	3.43	Agree
3. Strategies help learners connect new Science lessons with prior knowledge.	3.57	Agree
4. Strategies help learners follow and understand the steps in science problems or activities.	3.47	Agree
Retention		
5. Learners can still remember the main ideas of science lessons over time.	3.43	Agree
6. Learners can recall Science terms and definitions without notes.	3.32	Neutral
7. Strategies help remember key points from previous lessons when studying a new topic.	3.48	Agree
Retrieval		
8. Strategies help learners answer Science questions correctly on quizzes, tests, and class activities using what they learned.	3.68	Agree
9. Strategies help learners quickly recall science concepts when asked in class, during recitations, or in assessments.	3.42	Agree
10. Learners can apply previously learned science concepts to solve problems or complete activities in class and in real-life situations.	3.70	Agree
Average Weighted Mean	**3.56**	**Agree**

A. Comprehension. The results reveal that the strategies helped learners understand lessons better, as indicated by the highest mean score across all indicators (4.05). Learners were also able to explain lessons in their own words (3.43), link new content with prior knowledge (3.57), and follow and understand the steps in science problems or activities (3.47). These outcomes suggest that cognitive load management strategies enabled students to process information meaningfully rather than relying on surface-level memorization.

During the Focus Group Discussion (FGD), learners elaborated on how they perceive the effectiveness of these strategies in practice. They reported that they learn best through hands-on activities, visual aids, focused explanations or videos, group activities and active participation in experiments, all of which help them process and understand lessons more deeply.

These findings imply that incorporating varied and active learning strategies such as visuals, collaborative discussions, hands-on activities, and scaffolded explanations can significantly enhance students' comprehension of science concepts. Teachers may therefore design lessons that reduce extraneous cognitive load while promoting meaningful engagement, ensuring that learners not only memorize information but also understand and apply it effectively. These findings are supported by the study of Sozio, Agostinho, Tindall-Ford, and Paas (2024), which found that instructional strategies grounded in Cognitive Load Theory, particularly worked examples and structured learning guidance, significantly improved students' conceptual understanding and problem-solving performance by reducing unnecessary cognitive processing demands. The study emphasized that when learners are provided with clear instructional support, they are better able to organize information, connect concepts, and achieve deeper comprehension.

B. Retention. As shown in Table 3, learners reported that strategies helped them remember key points from previous lessons when studying a new topic (3.48) and recall the main ideas of science lessons over time (3.43). However, recalling specific terms and definitions without notes was rated slightly lower (3.32), suggesting that retention of detailed information may require additional reinforcement.

During FGDs, learners emphasized that strategies such as taking notes and reviewing them regularly, using keywords or mnemonics, and focusing on main ideas significantly supported their ability to retain information. These approaches allowed them to consolidate knowledge into mental schemas, facilitating repeated retrieval and longer-term retention. This aligns with Martin et al. (2021) who emphasized that learners' psychological orientations, such as confidence and motivation, influence how effectively knowledge is retained.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

These findings imply that retention can be strengthened when teachers integrate strategies that promote active engagement with content, such as note-taking, retention tasks, mnemonic devices, and focused review of key concepts. This highlights the importance of combining cognitive load principles with practical retention strategies to support long-term learning in science.

C. Retrieval. Learners reported that the strategies helped improve their ability to answer questions correctly using what they learned (3.68), quickly recall Science concepts when asked in class, during recitations, or in assessments (3.42), and apply lessons more effectively to problem-solving situations (3.70), as presented in Table 3. During Focus Group Discussions, learners further expressed that applying cognitive load management strategies enhanced their ability to answer questions, solve problems, and participate confidently in class activities or recitations. Some learners highlighted that strategies such as teacher explanations, watching videos, translating lessons into their mother tongue, and engaging in hands-on activities strengthened their capacity to recall and use knowledge effectively.

These results yielded an average of 3.56, indicating that learners generally agree that cognitive load management strategies positively impact influence their learning in Science. The findings demonstrate that cognitive load management strategies are highly effective in supporting learners' comprehension, retention, and retrieval of science content. Cognitive load management strategies not only enhance understanding but also improve students' ability to internalize and apply knowledge. These outcomes are consistent with recent studies such as Baxter, Sachdeva, and Baker (2025), which emphasize that applying Cognitive Load Theory principles reduces unnecessary mental demands and allows learners to focus on essential conceptual understanding. They also align with Fuentes and Chua (2025), who found that cognitive load–based instructional materials significantly enhance learners' comprehension and skill acquisition in Science.

These findings highlight that cognitive load management strategies are not only essential for strengthening learners' conceptual understanding, long-term knowledge retention, and application of scientific concepts but also serve as a foundation for effective instructional design in Science education. For teachers, this highlights the importance of using structured, scaffolded, and cognitively aligned strategies to support meaningful learning. For school leaders, the results emphasize the need to strengthen professional development initiatives that enhance teachers' ability to apply cognitive load–based practices. For curriculum developers, the findings point to the importance of designing Science materials that are well-sequenced, developmentally appropriate, and cognitively manageable to prevent learner overload. At the policy level, these results support the refinement of educational policies that promote learner-centered and cognitively responsive instruction to improve Science learning outcomes. Additionally, teacher education programs may integrate Cognitive Load Theory as a core component in preparing future educators for effective classroom practice.

4. Instructional Material Developed Based on the Findings of the Study

Based on the key findings of the study, a Cognitive Load–Based Activity Guide for Grade 7 Science titled C.L.E.A.R. Science (Cognitive Learning Enhancement Activity Resource) was developed to directly address learners' challenges in comprehension, retention, and retrieval of scientific concepts. The results revealed that learners experience difficulty when lessons contain dense information, lengthy explanations, and minimal scaffolding, which contribute to excessive cognitive load. On the other hand, learners demonstrated better understanding when lessons were structured, visually supported, engaging, and simplified. Guided by these findings, the developed material was intentionally designed to reduce unnecessary cognitive load while directing learners' attention to essential concepts, enabling more efficient information processing and sustained focus.

The developed material consists of organized, topic-based activities aligned with the Most Essential Learning Competencies (MELCs) for Quarter 1 Grade 7 Science. Each activity begins with concise learning objectives, key vocabulary, and a brief introduction that activates prior knowledge and prepares learners for the lesson. Tasks are broken down into smaller, logically sequenced steps to prevent cognitive overload, while visuals, diagrams, short videos, and brief explanations are incorporated to support dual coding and reinforce conceptual understanding. The guide also emphasizes exploration, critical thinking, and real-life application, consistent with the study's findings that learners demonstrate improved comprehension when activities are engaging and connected to familiar contexts.

The C.L.E.A.R. Science activity guide serves as a research-informed and theory-driven instructional material that responds directly to the documented needs of Grade 7 learners. It is intentionally designed to reduce cognitive overload while supporting meaningful and sustained learning.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

5. Curricular Validation of the Developed Cognitive Load-based Activity Guide for Grade 7 Science

This section presents the results and discussion of the curricular validation conducted on the developed Cognitive Load–Based Activity Guide for Grade 7 Science. The validation aimed to determine the extent to which the material aligns with established curricular standards and effectively supports learning in terms of content, instructional design, and pedagogical appropriateness. Expert evaluators assessed the guide using specific criteria outlined in the DepEd LRMDS tool, and weighted means were computed to indicate the overall level of effectiveness of the developed material.

Table 4

Summary of the Results of the Curricular Evaluation of the Developed Cognitive Load-based Activity Guide for Grade 7 Science

Factors/Indicators	Total Score	Required Points	Remarks
1. Content Quality	27.8	21-28	Passed
2. Format	70.3	54-72	Passed
3. Presentation and Organization	19.9	15-20	Passed
4. Accuracy and up-to-datedness of information	24	24	Passed

Table 4 summarizes the evaluation results of the developed Cognitive Load-based Activity Guide for Grade 7 Science across content quality, format, presentation and organization, and accuracy and up-to-datedness of information. The guide scored 27.8 points in content quality, indicating that the material is appropriate for the learners' developmental level and effectively supports the learning objectives. In the format category, it received 70.3 points, reflecting a visually appealing, well-organized, and user-friendly design. Presentation and organization earned 19.9 points, demonstrating a clear and logical arrangement of content that facilitates comprehension. Finally, accuracy and up-to-datedness of information achieved a perfect score of 24 points, confirming that the guide provides correct, reliable, and current Science content. Hence, the activity guide met the required evaluation criteria across all indicators, demonstrating that it is a high-quality, well-structured, and reliable learning resource capable of supporting meaningful Grade 7 Science learning and serving as a model for future instructional materials.

Conclusions

In light of the findings, the following conclusions were drawn:

1. The cognitive load challenges experienced by Grade 7 learners, particularly in processing complex scientific terms, multiple concepts, and large volumes of information, highlight the need for improved instructional design that aligns with learners' cognitive capacities. This contributes to enhancing teaching and learning processes in science education.

2. While learners employ basic cognitive load management strategies such as note-taking and highlighting, the limited use of higher-order metacognitive strategies indicates a need for explicit instructional support. This finding contributes to teacher professional development by emphasizing the importance of teaching learners how to learn.

3. Cognitive load management strategies significantly enhance learners' comprehension, retention, and retrieval of scientific concepts, demonstrating their value in improving learning outcomes and supporting evidence-based pedagogical practices.

4. The development of the C.L.E.A.R. Science activity guide represents a pedagogical innovation that integrates cognitive load theory into instructional material design. It contributes to curriculum development by providing a structured, learner-centered, and cognitively responsive resource aligned with Grade 7 learning competencies.

5. The successful curricular validation of the instructional material confirms its effectiveness and applicability in classroom settings, highlighting its potential to support teachers, school leaders, and curriculum developers in improving science education practices.

Recommendations

Based on the findings and conclusions, the following recommendations were formulated:

1. Science teachers may simplify technical terms, segment lesson content, and regulate instructional pacing to reduce cognitive overload and enhance learners' understanding of scientific concepts.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

2. Teachers may integrate explicit instruction on both basic and higher-order cognitive load management strategies, including summarizing, concept mapping, and study planning, to strengthen learners' independent learning skills.

3. Teachers may incorporate strategies that support comprehension, retention, and retrieval, such as activating prior knowledge, providing retrieval practice, and reinforcing key concepts through structured activities.

4. Grade 7 Science teachers may utilize the C.L.E.A.R. Science activity guide as a supplementary instructional resource and adapt its components based on learners' needs and classroom contexts.

5. School administrators may support the implementation of cognitive load–based instructional strategies by providing professional development programs and instructional supervision that promote effective teaching practices.

6. Curriculum developers may integrate cognitive load principles into the design of learning materials and curriculum frameworks to ensure that content is developmentally appropriate and cognitively manageable.

7. Education policymakers may consider supporting initiatives that promote research-based instructional innovations, such as cognitive load–based materials, to improve national learning outcomes in science.

8. Teacher education institutions may incorporate cognitive load theory and its practical applications into pre-service and in-service training programs to better prepare educators for effective classroom instruction.

9. Future researchers may explore the long-term impact of cognitive load–based instructional materials across different grade levels, subject areas, and educational contexts.

REFERENCES

Abeysekera, I., Sunga, E., Gonzales, A., & David, R. (2024). The effect of cognitive load on learning memory of online learning accounting students in the Philippines. *Sustainability*, *16*(4), 1686. https://doi.org/10.3390/su16041686

Alarcon, J. L. P. (2025). Analyzing learning experience and retention: The role of multimedia resources in physical science education. *Journal of Tertiary Education and Learning*, *3*(1), 44-50. https://doi.org/10.54536/jtel.v3i1.3276

Baxter, K. A., Sachdeva, N., & Baker, S. (2025). The application of cognitive load theory to the design of health and behavior change programs: Principles and recommendations. *Health Education & Behavior*, *52*(4), 469–477. https://doi.org/10.1177/10901981251327185

Capundan, L. B. (2025). Cognitive load and metacognition in the study of Filipino and language learning among Grade 7 students. *Pantao: The International Journal of the Humanities and Social Sciences*, *4*(3), 472–480. https://doi.org/10.69651/PIJHSS0403472

Castro-Alonso, J. C., de Koning, B. B., Fiorella, L., & Paas, F. (2021). Five strategies for optimizing instructional materials: Instructor- and learner-managed cognitive load. *Educational Psychology Review*, *33*(4), 1379–1407. https://doi.org/10.1007/s10648-021-09606-9

Del Mundo, D. C., & Caballes, D. G. (2022). Measuring cognitive load level in a multimedia learning environment towards the development of I-SIM. *Sapienza: International Journal of Interdisciplinary Studies*, *3*(1), 268–283. https://doi.org/10.51798/sijis.v3i1.232

Delos Santos, M. R., & Fiscal, R. R. (2024). Active learning strategies as a mediator between educational components and knowledge retention in science at LSPU-System. *International Research Journal of Science, Technology, Education, and Management*, *4*(3), 15–28. https://doi.org/10.5281/zenodo.13858745

Department of Education. (2005). *Instituting measures to increase engaged time-on-task and ensuring compliance therewith* (DepEd Order No. 9, s. 2005). https://www.deped.gov.ph/2005/03/02/do-9-s-2005-instituting-measures-to-increase-engaged-time-on-task-and-ensuring-compliance-therewith/

Department of Education. (2012). Policy guidelines on the implementation of Grades 1 to 10 of the K to 12 Basic Education Curriculum (BEC) effective school year 2012-2013 (DepEd Order No. 31, s. 2012).

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

https://www.deped.gov.ph/2012/04/17/do-31-s-2012-policy-guidelines-on-the-implementation-of-grades-1-to-10-of-the-k-to-12-basic-education-curriculum-bec-effective-school-year-2012-2013/

Estacio, R. D., Reyes, E. A. S., & Torrefranca, E. R. (2022). Graphic organizers and the level of students' performance and self-efficacy in an online learning environment. *International Journal of Scientific and Research Publications*, *12*(10), 414–423. http://dx.doi.org/10.29322/IJSRP.12.10.2022.p13056

Frianeza, E. D., et al. (2024). Challenges in the Philippine educational system and its impact on teachers' instructional strategies and professional growth. *Journal of Pedagogy and Education Science, 3*(1), 63–71. https://doi.org/10.56741/jpes.v3i01.414

Fuentes, M. M., & Chua, E. N. (2025). Customizing strategic intervention material utilizing cognitive load theory. *International Journal of Research Publication and Reviews*, *6*(6), 7536-7554. https://doi.org/10.55248/gengpi.6.0625.2265

Hartelt, T., & Martens, H. (2024). Self-regulatory and metacognitive instruction regarding student conceptions: Influence on students' self-efficacy and cognitive load. *Frontiers in Psychology*, *15*, Article 1450947. https://doi.org/10.3389/fpsyg.2024.1450947

Ilumin, R. A., Biscocho, S., & Garlan, M. J. (2025). Cognitive adjustments and coping strategies of students transitioning from elementary to junior high school science. *Philippine Journal of Science Education*, *14*(2). https://www.ejournals.ph/article.php?id=28144

Le Cunff, A.-L., Giampietro, V., & Dommett, E. (2024). Neurodiversity and cognitive load in online learning: A focus group study. *PLOS ONE*, *19*(4). https://doi.org/10.1371/journal.pone.0301932

Lee, C.-S., & Hughes, J. H. (2020). Refocusing on cognitive load design through a meta-analysis on learnability, goal-based intentions and extensibility: Towards personalized cognitive-social-affective engagement among seniors. *Studies in Health Technology and Informatics*, *270*, 1121–1125. https://ebooks.iospress.nl/publication/52709

Liu, D. (2024). The effects of segmentation on cognitive load, vocabulary learning and retention, and reading comprehension in a multimedia learning environment. *BMC Psychology*, *12*(4), 1–12. https://doi.org/10.1186/s40359-023-01489-5

Lopez, S. (2024). The impact of Cognitive Load Theory on the effectiveness of microlearning modules. *European Journal of Education and Pedagogy*, *5*(2), 29–35. https://doi.org/10.24018/ejedu.2024.5.2.799

Mangubat, J. P. L., & Paglinawan, J. L. (2024). Task complexity and students' cognitive load in science among Grade 11 students at Kitubo National High School, Bukidnon. *International Journal of Latest Technology in Engineering, Management & Applied Science, 13*(11), 116–123. https://doi.org/10.51583/IJLTEMAS.2024.1311012

Martin, A. J., Ginns, P., Burns, E. C., Kennett, R., Munro-Smith, V., Collie, R. J., & Pearson, J. (2021). Assessing instructional cognitive load in the context of students' psychological challenge and threat orientations: A multi-level latent profile analysis of students and classrooms. *Frontiers in Psychology*, *12*, 656517. https://doi.org/10.3389/fpsyg.2021.656994

Mayer, R. E., & Fiorella, L. (2021). Principles for managing essential processing in multimedia learning: Segmenting, pre-training, and modality principles. In R. E. Mayer & L. Fiorella (Eds.), The Cambridge Handbook of Multimedia Learning (3rd ed., pp. 243–260). *Cambridge University Press*. https://doi.org/10.1017/9781108894333.025

Orbeta, T. (2022). Managing cognitive resource expenditure and fostering creative thinking in biology teaching guided by instructional message design. *Philippine Journal of Science*, *151*(6B), 2379–2389.

International Journal of Education, Learning, and Pedagogical Sciences (INJELPS)
P - ISSN 3116-3769; E - ISSN 3116-3777
National Book Development Board (NBDB) Registration as Book Publisher (Print & Digital): 6312
PRC-CPD Accredited Provider: PTR-2025-749

https://philjournalsci.dost.gov.ph/managing-cognitive-resource-expenditure-and-fostering-creative-thinking-in-biology-teaching-guided-by-instructional-message-design/#:~:text=This%20study%20examined%20the%20effectiveness,among%20high%20school%20biology%20students.

Organisation for Economic Co-operation and Development. (2024). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing. https://doi.org/10.1787/53f23881-en

Sjöström, J. (2024). Vision III of scientific literacy and science education: An alternative vision for science education emphasising the ethico-socio-political and relational-existential. *Studies in Science Education*, *61*(2). https://doi.org/10.1080/03057267.2024.2405229

Sozio, G., Agostinho, S., Tindall-Ford, S., & Paas, F. (2024). Enhancing teaching strategies through cognitive load theory: Process vs. product worked examples. *Education Sciences*, *14*(8), 813. https://doi.org/10.3390/educsci14080813

Sweller, J. (2024). Cognitive load theory and individual differences. *Learning and Individual Differences*, *110*, Article 102423. https://doi.org/10.1016/j.lindif.2024.102423