Supplementary Visual Learning Materials for Grade 7 Physical Science: Development, Evaluation, and Impact on Student Performance

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ABSTRACT

Persistent low mastery in Grade 7 Physical Science competencies across public secondary schools in the Philippines underscores the need for targeted, evidence-based instructional materials. This study developed and evaluated Supplementary Visual Learning Materials (SVLMs) anchored on the least learned competencies of Grade 7 learners in three public secondary schools in Talacogon, Agusan del Sur, Philippines. Employing a developmental-evaluative research design guided by the ADDIE model, the study involved 90 Grade 7 learners (purposively selected based on pre-test performance), 14 Science teachers (complete enumeration), and five expert validators. Pre-test results confirmed that all six clustered Physical Science competency areas - heat transfer processes and particle model, heat energy and heat-to-electricity devices, effects of unbalanced forces, motion concepts and graphical representations, balanced and unbalanced forces with free-body diagrams, and forces acting between objects - were least learned (mastery range: 34.31%–52.22%). The developed SVLMs were rated Highly Appropriate in design ($M = 4.98$) and Very High in both pedagogical quality ($M = 4.97$) and effective integration into the teaching and learning process ($M = 4.98$). Teacher-observed student competency after exposure was rated Outstanding ($M = 4.99$). A paired samples t-test revealed a significant improvement in students' scores (pre-test $M = 16.88$; posttest $M = 26.71$; mean gain = 9.83; $t = 27.44$, $p < .001$), rejecting the null hypothesis of no improvement. Fisher's Exact Test showed a significant overall relationship between students' competency and design appropriateness ($p = .013$), particularly for behavioral engagement ($p = .021$). No significant relationship was found between pedagogical quality and effective integration ($p = .163$), and no significant difference was observed between student and teacher ratings of effective integration (Mann–Whitney $U = 593.00$, $p = .642$). The findings affirm that targeted, visually organized, and cognitively scaffolded instructional materials can produce meaningful improvements in Physical Science achievement, while highlighting that continued remediation and teacher facilitation are essential for learners to reach acceptable mastery thresholds.

Keywords: supplementary visual learning materials, physical science, least learned competencies, ADDIE model, cognitive load theory, multimedia learning, Philippines

INTRODUCTION

Persistent underachievement in science remains one of the most pressing challenges confronting Philippine basic education. The PISA 2022 results placed Filipino students below the OECD average in science, indicating systemic difficulty in applying scientific knowledge to interpret data, recognize explanations, and engage with real-world phenomena (OECD, 2023). These national deficiencies are compounded at the local level, where public secondary schools in geographically dispersed communities such as Talacogon, Agusan del Sur contend with limited laboratory facilities, insufficient printed learning resources, and restricted access to digital instructional tools. In such resource-constrained settings, the gap between the competencies expected under the MATATAG Science Curriculum and the instructional support available to learners is both pronounced and persistent (Department of Education, 2023; EDCOM II, 2025).

Grade 7 Physical Science presents particular instructional challenges because its core competencies - force, motion, heat transfer, energy transformation, particle interactions, and graphical representations - require learners to visualize processes that are abstract, microscopic, or not directly observable. When classroom instruction relies primarily on verbal explanation or text-heavy printed materials, learners who have not yet consolidated foundational scientific literacy skills are at significant risk of developing misconceptions or failing to achieve the minimum mastery threshold. The Cognitive Theory of Multimedia Learning (CTML) established by Mayer (2021) provides the theoretical rationale for addressing this challenge: learners comprehend complex scientific content more effectively when verbal and visual information are coherently integrated, reducing extraneous cognitive load and enabling the construction of accurate mental models.

Despite a growing body of international and Philippine-based evidence supporting visual and supplementary instructional materials in science education (Bautista & Lim, 2022; Orlanda-Ventayen & Ventayen, 2021; Bello et al., 2023), few studies have systematically identified least learned competencies through actual performance data, developed targeted visual materials in direct response to those gaps, and subjected the materials to multi-dimensional evaluation encompassing design appropriateness, pedagogical quality, classroom integration, and student performance impact. This dual gap - empirical and methodological - motivates the present study, which situates instructional material development within an ADDIE framework and evaluates outcomes across multiple assessment dimensions in a rural Philippine public school context where such evidence is critically needed.

The study pursued the following research objectives: (1) to identify the least learned competencies of Grade 7 learners in Physical Science based on pre-test scores; (2) to determine the level of design appropriateness of the developed SVLMs; (3) to determine the level of pedagogical quality; (4) to assess the level of effective integration into the teaching and learning process; (5) to determine the perceived level of students' competency after exposure to the SVLMs; (6) to examine whether a significant improvement in students' scores occurred after using the SVLMs; (7) to test whether students' competency was significantly related to design appropriateness; (8) to test whether pedagogical quality was significantly related to effective integration; and (9) to test whether students and teachers significantly differed in their ratings of effective integration.

Theoretical Framework

This study is grounded in three complementary theoretical traditions that collectively explain how visual supplementary materials may address persistent learning gaps in abstract science concepts.

Cognitive Theory of Multimedia Learning (CTML; Mayer, 2021) served as the primary theoretical anchor. CTML posits that meaningful learning is achieved when learners process information through dual channels - verbal and visual - and actively select, organize, and integrate incoming information with prior knowledge. For Grade 7 Physical Science, where learners must comprehend invisible processes such as particle movement during heat transfer, magnitude and direction of forces in free-body diagrams, and energy transformation in thermoelectric devices, the coherent integration of diagrams, illustrations, visual organizers, and explanatory text is not merely supplementary but cognitively essential. Mayer's principles of coherence, signaling, spatial contiguity, and segmenting directly guided the design architecture of the SVLMs developed in this study (De Koning & Van der Schoot, 2020; Lowe & Schnotz, 2021).

Cognitive Load Theory (CLT; Sweller et al., 2020) provided the second theoretical layer by explaining how instructional design can be optimized to respect the constraints of working memory. CLT distinguishes three types of cognitive load: intrinsic load (complexity inherent to the subject matter), extraneous load (unnecessary mental effort imposed by poor design), and germane load (effort directed toward schema construction). The SVLMs were designed to minimize extraneous load through simplified, properly labeled visual presentations, logical sequencing, and avoidance of cluttered or irrelevant graphical elements, thereby releasing working memory capacity for genuine conceptual processing (Leppink, 2021; Jeyaraman et al., 2024).

Constructivist Learning Theory (Piaget; Vygotsky, as operationalized in Tomlinson, 2021; Zhang & Linn, 2023) completed the theoretical framework by explaining how learners actively construct understanding through guided experience and scaffolded interaction. The SVLMs incorporated learner-centered activities, metacognitive prompts, reflective guide questions, and contextualized examples - design features that operationalize constructivist scaffolding within the physical constraints of a printed supplementary material. Together, the three theories provided a coherent and mutually reinforcing basis: CTML specified how visual-verbal integration supports comprehension; CLT specified how design should manage cognitive demands; and constructivism specified how learners should actively engage with materials to construct meaningful scientific knowledge.

METHODS

Research Design

The study employed a developmental-evaluative research design guided by the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), supplemented by a one-group pre-test and posttest design to evaluate student performance improvement. This combined design is well-suited to studies that produce a validated instructional product and simultaneously assess its educational impact within the same research cycle (Jaya et al., 2021; Spatioti et al., 2022; Hanis et al., 2025). Correlational and comparative components were integrated to test relationships and group differences among the evaluation variables.

Research Locale and Participants

The study was conducted in three public secondary schools in Talacogon, Agusan del Sur: Labnig National High School, Buena Gracia National High School, and Causwagan National High School. These schools were purposively selected on the basis of documented low mastery in Grade 7 Physical Science, predominantly rural learner populations, and limited access to science laboratory and digital learning resources - conditions that reflect the instructional gap targeted by this intervention. The study was conducted during the Third Quarter of School Year 2025–2026. Table 1 shows the distribution of respondents.

Table 1. Distribution of Research Respondents by School and Type

Type of Respondents	**Population**	**Sample**	**Sampling Technique**
Students			
Labnig National High School	83	30	Top 30 low-performing learners (pre-test)
Buena Gracia National High School	52	30	Top 30 low-performing learners (pre-test)
Causwagan National High School	67	30	Top 30 low-performing learners (pre-test)
Subtotal – Students	202	90	Purposive sampling
Science Teachers	14	14	Complete enumeration
Expert Validators	5	5	Purposive sampling
Total	221	109	

Note. Student selection based on top 30 low-performing learners per school (pre-test/diagnostic scores). Teacher respondents included through complete enumeration. Expert validators selected purposively by expertise.

The 90 student respondents were selected purposively: the top 30 lowest-performing Grade 7 learners from each school were identified based on their Science 7 Quarter 3 pre-test scores, ensuring that the study focused on the learners with the greatest instructional need. The 14 Science teachers were included through complete enumeration. Five expert validators were selected based on their professional backgrounds in science education, curriculum supervision, and instructional materials development (Campbell et al., 2020; Creswell & Creswell, 2023).

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Instruments

Four instruments were used. A 50-item Science 7 pre-test and posttest, adapted from Quarter 3 assessment materials and aligned with the six target competency clusters, served as the primary performance measure. The Expert Validation Tool for the SVLMs, adapted from DepEd LRMDS standards, was used to assess content accuracy, instructional alignment, and material quality. A researcher-made Likert-scale questionnaire (1 = Strongly Disagree/Never to 5 = Strongly Agree/Always) was administered to students and teachers to evaluate design appropriateness, pedagogical quality, and effective integration, as well as teacher-observed student competency after exposure. All instruments underwent face and content validation by the five expert validators prior to administration. Reliability was established through pilot testing with a comparable group of 30 respondents, yielding a Cronbach's alpha of 0.984 - an indicator of very high internal consistency.

Development Procedure: ADDIE Phases

During the Analysis phase, pre-test scores from 90 Grade 7 learners were examined to identify the six clustered Physical Science topic areas where learners demonstrated least mastery. During the Design phase, the structure, learning objectives, visual layout, activity sequences, guide questions, and formative checks of the SVLMs were planned in alignment with the identified least learned competencies and the target Grade 7 level. During the Development phase, SVLMs were produced as supplementary instructional materials incorporating diagrams, graphic organizers, labeled illustrations, guided examples, scenario-based activities, and structured visual prompts. During the Implementation phase, the SVLMs were used by selected Grade 7 learners under teacher supervision during scheduled Physical Science lessons. During the Evaluation phase, evaluation instruments were administered to collect data on design appropriateness, pedagogical quality, effective integration, and teacher-observed student competency, followed by post-test administration.

Data Analysis

Data were processed using Microsoft Excel and Jamovi. Frequency count, percentage, and percentage mastery identified least learned competencies. Weighted mean and standard deviation described the levels of design appropriateness, pedagogical quality, effective integration, and student competency. A paired samples t-test (H_{01}) determined whether students' scores significantly improved after exposure to the SVLMs. Fisher's Exact Test (H_{02}, H_{03}) examined the relationships between students' competency and design appropriateness, and between pedagogical quality and effective integration. The Mann–Whitney U test (H_{04}) determined whether students and teachers differed in their ratings of effective integration. All inferential tests were conducted at the $\alpha = 0.05$ level of significance.

RESULTS AND DISCUSSION

Least Learned Competencies in Grade 7 Physical Science

Table 2 presents the percentage mastery scores of the six clustered Grade 7 Physical Science competency areas based on the 50-item pre-test administered to 90 learners.

Table 2. Least Learned Competencies Based on Pre-test Performance

Clustered Competency	Learning Competencies	Items	Mastery (%)	Interpretation
Heat Transfer Processes & Particle Model	LC 9–10: Conduction, convection, radiation; particle model of heat transfer	40–47	34.31	Least Learned
Heat Energy & Heat-to-Electricity Devices	LC 8, 11: Heat vs. temperature; heat-to-electricity devices	36–39; 48–50	37.94	Least Learned

Effects of Unbalanced Forces	LC 4: Changes in speed/direction due to unbalanced forces	18–21	41.67	Least Learned
Motion Concepts & Graphical Representations	LC 5–7: Distance/displacement; speed/velocity; distance-time graphs	22–35	44.44	Least Learned
Balanced & Unbalanced Forces with Free-Body Diagrams	LC 2–3: Balanced/unbalanced forces; free-body diagrams	6–17	46.11	Least Learned
Forces Act Between Objects	LC 1: Forces act between objects and can be measured	1–5	52.22	Least Learned

Note. Mastery below 60% is classified as Least Learned in accordance with DepEd standards.

All six clustered competency areas registered percentage mastery scores below the 60% threshold, confirming least learned status across the board. The lowest mastery was recorded for Heat Transfer Processes and Particle Model (34.31%), followed by Heat Energy and Heat-to-Electricity Devices (37.94%), Effects of Unbalanced Forces (41.67%), Motion Concepts and Graphical Representations (44.44%), Balanced and Unbalanced Forces with Free-Body Diagrams (46.11%), and Forces Act Between Objects (52.22%). The steepest learning deficits concentrated in thermodynamic and energy transformation competencies, which require learners to reason about microscopic particle behavior and invisible energy transfer processes - precisely the conditions under which CTML and CLT predict that unaided verbal instruction fails (Mayer, 2021; Sweller et al., 2020). The comparatively higher mastery for Forces Act Between Objects likely reflects learners' greater experiential familiarity with macroscopic force interactions in daily life. These results provided the empirical foundation for the targeted development of SVLMs, consistent with the approach endorsed by Bello et al. (2023) and Bobis-Antonio (2023), who demonstrated that instructional materials grounded in actual learner performance data produce more educationally meaningful outcomes than generic remediation resources.

Design Appropriateness of the Developed SVLMs

Table 3 presents the level of design appropriateness of the developed SVLMs as evaluated by students and teachers.

Table 3. Level of Design Appropriateness of the Developed SVLMs

Indicator	**Student Mean**	**Teacher Mean**	**Overall Mean**	**SD**	**Rating**
Perceptual Clarity & Organization	4.98	4.96	4.98	0.07	Highly Appropriate
Cognitive Load Management	4.98	4.99	4.98	0.06	Highly Appropriate
Metacognitive Support	4.98	4.99	4.98	0.06	Highly Appropriate
Instructional Alignment & Sequencing	4.96	4.99	4.97	0.09	Highly Appropriate
Accessibility and Usability	4.98	4.96	4.98	0.08	Highly Appropriate
Overall	4.98	4.97	4.98	0.04	Highly Appropriate

Note. Scale: 4.51–5.00 = Highly Appropriate; 3.51–4.50 = Appropriate; 2.51–3.50 = Moderately Appropriate.

The SVLMs were rated Highly Appropriate overall (M = 4.98, SD = 0.04), with all five design dimensions receiving the same overall rating. Perceptual Clarity and Organization, Cognitive Load Management,

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Metacognitive Support, and Accessibility and Usability tied for the highest individual means (M = 4.98), while Instructional Alignment and Sequencing recorded the marginally lowest mean (M = 4.97), though it remained firmly within the Highly Appropriate range. The uniformly high ratings across both student and teacher respondents indicate strong cross-group consensus that the materials were visually coherent, cognitively manageable, well-organized, and accessible for Grade 7 learners. These results are consistent with Mayer's (2021) multimedia learning principles - particularly coherence, signaling, and spatial contiguity - which predict that materials designed around learners' dual-channel processing capacities will be perceived as clear and usable. The slight plateau in Instructional Alignment and Sequencing is theoretically interpretable: even when individual visual components are clear, transitions between simple and complex concepts in abstract Physical Science topics may require finer-grained pedagogical scaffolding than a supplementary print material can fully provide, a limitation also noted by De Koning and Van der Schoot (2020) in their review of structured visual representations in science.

Pedagogical Quality of the Developed SVLMs

Table 4 presents the level of pedagogical quality of the SVLMs across five dimensions.

Table 4. Level of Pedagogical Quality of the Developed SVLMs

Indicator	**Student Mean**	**Teacher Mean**	**Overall Mean**	**SD**	**Rating**
Content and Task Analysis	4.98	4.96	4.98	0.06	Very High
Learner-Centered Design	4.97	4.99	4.98	0.07	Very High
Instructional & Visual Strategy Alignment	4.97	4.94	4.97	0.08	Very High
Message and Visual Design Quality	4.96	4.94	4.96	0.09	Very High
Formative Evaluation and Revision	4.98	4.99	4.98	0.07	Very High
Overall	**4.97**	**4.96**	**4.97**	**0.04**	**Very High**

Note. Scale: 4.51–5.00 = Very High; 3.51–4.50 = High; 2.51–3.50 = Moderate.

The SVLMs achieved a Very High overall pedagogical quality rating (M = 4.97, SD = 0.04). Content and Task Analysis, Learner-Centered Design, and Formative Evaluation and Revision recorded the highest dimension means (M = 4.98), indicating strong alignment with the identified least-learned competencies, appropriate responsiveness to learners' needs and developmental levels, and systematic incorporation of expert feedback during development. Message and Visual Design Quality had the lowest mean (M = 4.96), a finding that, while still Very High, suggests that the illustrations and scenario framing of some material components may benefit from further contextualization and age-appropriate updates in subsequent iterations. This finding aligns with Tomlinson's (2021) emphasis on learner-centered differentiation - that instructional materials must not only address cognitive demands but must also resonate with learners' lived experiences and developmental readiness. The high rating for Formative Evaluation and Revision reflects the iterative expert validation process embedded in the ADDIE development cycle (Branch & Kopcha, 2023), confirming that structured developmental procedures produce materials of demonstrably higher instructional quality.

Effective Integration into the Teaching and Learning Process

Table 5 presents the combined student and teacher ratings of the SVLMs' effective integration.

Table 5. Level of Effective Integration of the Developed SVLMs into the Teaching and Learning Process

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Indicator	Student Mean	Teacher Mean	Overall Mean	SD	Rating
Integration Strategy	4.98	5.00	4.98	0.06	Very High
Instructional Facilitation	4.98	4.99	4.98	0.06	Very High
Access and Usability	4.98	5.00	4.99	0.05	Very High
Student Interaction	4.98	5.00	4.98	0.08	Very High
Contextual Adaptation	4.98	4.97	4.98	0.06	Very High
Overall	4.98	4.99	4.98	0.03	Very High

Note. Scale: 4.51–5.00 = Very High; 3.51–4.50 = High. Results reflect combined student and teacher ratings.

The SVLMs received a Very High overall effective integration rating (M = 4.98, SD = 0.03). Access and Usability obtained the highest dimension mean (M = 4.99), indicating that the materials were perceived as physically accessible, easy to handle, and straightforward to use during classroom activities - a particularly meaningful finding in resource-constrained rural schools where instructional material complexity can itself become a barrier to implementation. All other dimensions - Integration Strategy, Instructional Facilitation, Student Interaction, and Contextual Adaptation - also achieved Very High ratings, reflecting broad agreement that the SVLMs were appropriately embedded within Physical Science instruction, effectively facilitated by teachers, actively engaged by students, and adaptable to the varying classroom conditions across the three participating schools. These findings are consistent with Darling-Hammond et al. (2022), who emphasized teacher facilitation as a critical determinant of effective material implementation, and with Fullan's (2021) observation that educational innovations succeed when they are adaptable to real classroom realities rather than prescribed as fixed protocols.

Perceived Level of Students' Competency After Exposure

Table 6 presents the teacher-observed level of students' competency across five dimensions following exposure to the SVLMs.

Table 6. Perceived Level of Students' Competency in Physical Science After Exposure to the SVLMs

Indicator	Weighted Mean	SD	Rating
Performance Accuracy	4.99	0.05	Outstanding
Conceptual Understanding	4.99	0.05	Outstanding
Skill Application	4.99	0.05	Outstanding
Behavioral Engagement	4.99	0.05	Outstanding
Cognitive and Emotional Engagement	4.99	0.05	Outstanding
Overall	4.99	0.04	Outstanding

Note. Scale: 4.51–5.00 = Outstanding; 3.51–4.50 = Very Satisfactory. Ratings based on teacher observation.

Teachers rated students' competency as Outstanding across all five dimensions (M = 4.99, SD = 0.04). The uniformity of this rating across Performance Accuracy, Conceptual Understanding, Skill Application, Behavioral Engagement, and Cognitive and Emotional Engagement reflects strong teacher consensus that learners demonstrated observable improvements in all competency domains after exposure to the SVLMs. The consistency of outstanding ratings across all dimensions is theoretically supported by Mayer (2021), who explained that well-designed visual-verbal integration supports both information organization and schema formation, and by Thompson et al. (2022), who found that visually enriched instruction significantly increased learner attention and motivation. However, these consistently ceiling-level ratings warrant interpretive caution: the limited variance (SD = 0.04–0.05) may partially reflect a common method effect or rating tendency among teacher-evaluators. The Outstanding teacher-observed competency should therefore be interpreted alongside the objective pre-test and posttest performance data rather than as a standalone finding.

Significant Improvement in Students' Scores

Table 7 presents the paired samples t-test results comparing students' pre-test and posttest scores.

Table 7. Paired Samples t-Test on Pre-test and Posttest Scores of Students

Pre-test Mean	Posttest Mean	Mean Gain	t-value	df	p-value	Decision	Interpretation
16.88	26.71	9.83	27.44	89	< 0.001	Reject H_{01}	Significant Improvement

Note. Pre-test M = 16.88 (33.76%); Posttest M = 26.71 (53.42%). Mastery criterion = 60%. N = 90.

The null hypothesis (H_{01}) was rejected. The paired samples t-test revealed a statistically significant improvement in students' scores ($t = 27.44$, $df = 89$, $p < .001$), with a mean gain of 9.83 points representing an increase from 33.76% to 53.42% in percentage mastery. This result confirms that the SVLMs produced a measurable and significant instructional effect within the intervention period. These findings are consistent with Bello et al. (2023) and Bobis-Antonio (2023), who similarly reported significant pre-test to posttest improvements following targeted supplementary material interventions in Philippine science classrooms. Critically, however, the posttest percentage mastery of 53.42% remained below the 60% mastery threshold, indicating that while the SVLMs generated meaningful learning gains, a single-cycle intervention was insufficient to bring all low-performing learners to acceptable mastery. This finding aligns with Sweller et al.'s (2020) caution that cognitively demanding content - particularly concepts involving invisible physical processes and abstract scientific relationships - requires repeated exposure, guided practice, and iterative reinforcement rather than one-time instructional contact. The result underscores the importance of treating the SVLMs as components of a sustained remediation strategy rather than standalone interventions.

Relationship Between Students' Competency and Design Appropriateness

Table 8 presents the Fisher's Exact Test results examining the relationship between teacher-observed student competency and design appropriateness.

Table 8. Fisher's Exact Test: Relationship Between Students' Competency and Design Appropriateness

Students' Competency Indicator	p-value	Decision	Interpretation
Performance Accuracy	.433	Fail to Reject H_{02}	Not Significant
Conceptual Understanding	.181	Fail to Reject H_{02}	Not Significant
Skill Application	.213	Fail to Reject H_{02}	Not Significant
Behavioral Engagement	.021	Reject H_{02}	Significant
Cognitive & Emotional Engagement	.247	Fail to Reject H_{02}	Not Significant

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Overall Students' Competency	**.013**	**Reject H_{02}**	**Significant**

The null hypothesis (H_{02}) was partially rejected. The overall relationship between students' competency and design appropriateness was significant ($p = .013$). At the indicator level, Behavioral Engagement demonstrated a significant relationship with design appropriateness ($p = .021$), while Performance Accuracy ($p = .433$), Conceptual Understanding ($p = .181$), Skill Application ($p = .213$), and Cognitive and Emotional Engagement ($p = .247$) did not reach significance. The significant association at the overall and behavioral engagement levels suggests that visually clear, organized, and accessible materials are particularly effective at stimulating active learner participation - a finding consistent with Thompson et al. (2022), who reported that visually enriched instruction increased attentional engagement, and with Jeyaraman et al. (2024), who linked reduced cognitive load through structured visuals to stronger behavioral involvement in learning tasks. The non-significant associations for performance accuracy, conceptual understanding, and skill application indicate that these more cognitively complex competency dimensions are influenced by factors beyond material design quality, including prior knowledge, teacher facilitation quality, task difficulty, and time-on-task - consistent with Sweller et al.'s (2020) position that design alone cannot fully compensate for high intrinsic cognitive load in abstract science domains.

Relationship Between Pedagogical Quality and Effective Integration

Table 9 presents the Fisher's Exact Test results examining the relationship between pedagogical quality and effective integration.

Table 9. Fisher's Exact Test: Relationship Between Pedagogical Quality and Effective Integration

Pedagogical Quality Indicator	**p-value**	**Decision**	**Interpretation**
Content and Task Analysis	.726	Fail to Reject H_{03}	Not Significant
Learner-Centered Design	.476	Fail to Reject H_{03}	Not Significant
Instructional & Visual Strategy Alignment	.549	Fail to Reject H_{03}	Not Significant
Message and Visual Design Quality	.131	Fail to Reject H_{03}	Not Significant
Formative Evaluation and Revision	.723	Fail to Reject H_{03}	Not Significant
Overall Pedagogical Quality	.163	Fail to Reject H_{03}	Not Significant

The null hypothesis (H_{03}) was not rejected. No significant relationship was found between pedagogical quality and effective integration at either the indicator level or overall ($p = .163$). This result indicates that high pedagogical quality in the materials did not automatically translate into proportionally higher effective classroom integration. The finding is theoretically explicable: classroom integration is mediated by implementation-level variables - teacher preparedness, time allotment, classroom management capacity, learner readiness, and resource availability - that operate independently of the intrinsic instructional quality of the materials (Darling-Hammond et al., 2022; Fullan, 2021; Koehler & Mishra, 2021). Practically, this means that pedagogically sound materials remain dependent on a competent and facilitative instructional context to realize their full effectiveness. This finding carries a policy implication: schools investing in the development of high-quality supplementary materials must simultaneously invest in teacher capacity building and classroom support structures to bridge the quality-integration gap.

Difference Between Student and Teacher Ratings of Effective Integration

Table 10 presents the Mann–Whitney U test results examining whether students and teachers differed in their ratings of the SVLMs' effective integration.

Table 10. Mann–Whitney U Test: Difference Between Student and Teacher Ratings of Effective Integration

Indicator	**Student Mean**	**Teacher Mean**	**Student Rank**	**Teacher Rank**	**U**	**p-value**	**Interpretation**
Integration Strategy	4.98	5.00	51.80	57.00	567.00	.222	Not Significant
Instructional Facilitation	4.98	4.99	52.53	52.32	632.50	.965	Not Significant
Access and Usability	4.98	5.00	51.96	56.00	581.00	.287	Not Significant
Student Interaction	4.98	5.00	52.19	54.50	602.00	.432	Not Significant
Contextual Adaptation	4.98	4.97	53.02	49.14	677.00	.337	Not Significant
Overall	4.98	4.99	52.09	55.14	593.00	.642	Not Significant

Note. All p-values > 0.05; null hypothesis retained for all indicators and overall.

The null hypothesis (H_{04}) was not rejected. No significant difference was found between students' and teachers' ratings of effective integration at either the indicator level or overall (U = 593.00, p = .642). Both groups consistently rated the SVLMs at the Very High level, with minimal differences in rank across all five integration dimensions. This convergence of perspectives from learners and instructors is a particularly meaningful finding: it confirms that the materials were not merely designed to satisfy institutional evaluation criteria but were genuinely perceived as effective and usable by both the learners who engaged with them and the teachers who facilitated their use. This bilateral acceptance is a critical predictor of long-term adoption and scalability (Fullan, 2021; Graham et al., 2020), suggesting that the SVLMs possess the stakeholder acceptance necessary for sustained integration into Grade 7 Physical Science instruction beyond the period of formal study.

CONCLUSION

This study developed and evaluated Supplementary Visual Learning Materials designed to address persistently low mastery in six clustered Grade 7 Physical Science competencies at three rural public secondary schools in Talacogon, Agusan del Sur, Philippines. Pre-test data confirmed that all six competency clusters were least learned, with percentage mastery ranging from 34.31% to 52.22%, establishing an empirically grounded and educationally urgent basis for targeted instructional intervention. The developed SVLMs were rated Highly Appropriate in design (M = 4.98) and Very High in both pedagogical quality (M = 4.97) and effective integration (M = 4.98), reflecting multi-stakeholder consensus across students, teachers, and expert validators. Teacher-observed student competency after exposure was rated Outstanding (M = 4.99) across all five competency dimensions. A significant improvement in students' scores was confirmed (mean gain = 9.83; t = 27.44, p < .001), representing growth from 33.76% to 53.42% mastery - a meaningful instructional effect, though one that still fell short of the 60% mastery criterion, signaling the need for sustained remediation and continued material refinement.

Inferential analyses revealed that design appropriateness was significantly related to students' overall competency (p = .013), particularly behavioral engagement (p = .021), affirming that visually clear and organized materials strengthen active learner participation in Physical Science tasks. No significant relationship was found between pedagogical quality and effective integration (p = .163), underscoring that high-quality materials still require a facilitative instructional context - competent teacher implementation, adequate time, and appropriate classroom conditions - to be fully effective. The consensus between student and teacher integration ratings (p = .642) indicates broad stakeholder acceptance that bodes well for the materials' adoptability and scalability.

The study makes three contributions to the science education literature. Theoretically, it operationalizes a triple-framework integration - CTML, CLT, and Constructivism - within a single supplementary material development cycle, demonstrating how these complementary theories can be jointly applied to address abstract Physical

Science learning gaps in low-resource Philippine classrooms. Methodologically, it demonstrates the value of a developmental-evaluative design that uses actual learner performance data as the empirical basis for material development and subjects outcomes to multi-dimensional, multi-group evaluation. Practically, it provides a validated and replicable model for LRMDS coordinators, curriculum developers, and science teachers in producing targeted visual instructional resources aligned with the MATATAG Science Curriculum. Future research should employ quasi-experimental designs with matched control groups to isolate the effect of the SVLMs from confounding instructional variables, examine long-term retention after extended material use, and investigate whether scenario-based revisions to the materials - prioritizing locally grounded examples and updated illustrations - further narrow the gap between intervention-produced gains and the mastery threshold.

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