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RESEARCH ARTICLE

DEVELOPMENT AND VALIDATION OF INTERACTIVE E-LEARNING MATERIALS IN SCIENCE 5

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Abstract

This study aimed to develop and validate eight interactive e-learning materials for Grade 5 Science in Flora, Apayao, with the goal of enhancing student learning, improving curriculum implementation, and addressing local educational gaps. Guided by the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model, the process involved the systematic design and refinement of the materials. A quantitative research design was employed to assess the effectiveness of the outputs, with ten evaluators—comprising Science teachers, master teachers, and school heads—serving as expert panelists. The evaluation focused on three key categories: learning environment, teaching-learning process, and learning assessment. Results indicated a high overall mean score of 4.48, suggesting strong agreement among experts regarding the effectiveness, usability, and learner engagement provided by the materials. These findings affirm the significant potential of the developed e-learning materials to improve conceptual understanding, foster student motivation, and elevate the quality of science instruction in the basic education setting.

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INTRODUCTION

The educational context of the 21st century constantly changes, presenting more challenges for educators to offer students an effective and engaging learning experience. Information Communication Technology (ICT) is regarded as having great potential for improving education through interactive e-learning materials (Mikre, 2011). These digital assets can support active learning and foster more dynamic learning environments. However, to reach this potential, careful attention should be paid to the local situation, needs, and current disparities, particularly in underprivileged areas.

Challenges in the Philippine education system are evident in the country's poor performance in international assessments such as the Programme for International Student Assessment (OECD, 2024). These evaluations reveal substantial problems in student achievement, particularly in reading, mathematics, and science, which underscore the urgent need for educational reform. The enhancement of science education is especially crucial to equip students with the necessary knowledge, values, and skills for success in a rapidly transforming world (Panigrahi et al., 2021).

Key initiatives at the national level, such as the DepEd Computerization Program (DCP) and the promotion of Open Educational Resources (OER), represent significant efforts to democratize access to information and improve educational outcomes in the Philippines (Open Educational Resources, n.d.). These initiatives aim to increase student and teacher access to digital technologies and educational content. However, their widespread dissemination remains challenging, particularly in remote and rural areas, despite the successful delivery of curriculum at the local level (Pascua & Bawang, 2017).

In Flora, Apayao, the integration of technology in education presents both opportunities and constraints. Schools in this locality face challenges such as poor infrastructure, limited internet connectivity, and insufficient access to high-quality digital resources aligned with the local curriculum (Apayao Department of Education Office, 2020). This context accentuates the critical importance of locally responsive e-learning materials that address the unique learning needs of students in underserved communities, with the potential to significantly enhance educational outcomes and bridge existing gaps in science education.

RESEARCH OBJECTIVES

The primary objective of this study was to develop and validate interactive e-learning materials tailored for Grade 5 Science. Specifically, it aimed to identify appropriate digital learning resources derived from the Most Essential Learning Competencies (MELCs) in the said subject. Furthermore, the study sought to evaluate the developed e-learning materials based on the assessments of teacher-experts. This evaluation focused on three key domains: the learning environment, the teaching-learning process, and the learning assessment. Through this, the research intended to determine the perceived effectiveness, usability, and pedagogical value of the materials in enhancing science instruction at the elementary level.

METHODOLOGY

The study utilized quantitative and developmental research designs to effectively achieve its objectives. Quantitative research, as defined by Creswell (2014), involves the systematic investigation of phenomena through the collection of numerical data and the application of statistical techniques to understand patterns and relationships. In this study, the quantitative component focused on the evaluation of the developed interactive e-learning materials using expert ratings across three key domains: the learning environment, the teaching-learning process, and learning assessment. Subject matter experts and instructional material (IM) specialists assessed the materials using a standardized evaluation tool, and the resulting data were analyzed through statistical measures such as mean and standard deviation to determine quality and effectiveness.

Developmental research, according to Richey and Klein (2007), pertains to the systematic design, development, and evaluation of instructional programs, products, and processes that fulfill established learning goals. In this study, the developmental component was implemented using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), a widely accepted framework in instructional design. This model facilitated a structured, iterative development process that ensured alignment with curriculum standards and responsiveness to the needs of Grade 5 Science learners. Feedback from experts during the evaluation stage was utilized to further refine the materials, thereby enhancing their usability and instructional value.

The integration of these two research designs was considered appropriate, as it provided a comprehensive approach to both the creation and validation of the e-learning materials. The developmental design enabled systematic and context-specific material development, while the quantitative design offered empirical evidence of their effectiveness. Collectively, these designs supported the goal of producing pedagogically sound and validated interactive e-learning resources for classroom application.

Table 1. Evaluators of the e-learning Materials in Science 5

Evaluators	Frequency	Percentage
Master Teachers	3	30.00
Teachers teaching Science	5	50.00
School Head	2	20.00
Total	10	100.00

The table above shows the panel of 10 evaluators involved in the study, which includes master teachers, regular science teachers, and school heads, all with at least five years of teaching experience. Master teachers provide insights into instructional design and best practices, while regular teachers offer practical feedback on classroom implementation and student needs. School heads contribute a broader perspective on curriculum integration and institutional support. This diverse expertise ensures a comprehensive evaluation of the interactive e-learning materials, aligning them effectively with the needs of fifth-grade science students.

In this study, one primary assessment tool was utilized to gather the necessary data. A survey-questionnaire designed for Science experts served as the primary instrument. This tool is an inventory of quality elements specific to e-learning materials in Science 5 and was adopted from the study by Mingorance-Estrada, Granda Vera, Rojas-Ruiz, and Alemany-Arrebola [13]. The questionnaire consisted of three key domains: ten (10) indicators for evaluating the learning environment, ten (10) indicators for the teaching-and-learning process, and ten (10) indicators for learning assessment. The learning environment includes the physical and online spaces where learning happens, focusing on accessibility, comfort, resources, design, and compatibility with different devices. The teaching-learning process involves the interactions between teachers and students, the teaching methods used, and strategies to keep students engaged and understanding the material. Learning assessment also refers to the ways we evaluate how well students grasp the content, using tools like quizzes, assignments, and interactive activities that align with learning objectives and offer quick feedback for improvement.

A Likert scale was employed to measure the responses systematically, ensuring the collection of quantitative data that could support the evaluation and validation of the developed materials.

Table 2. Evaluation and Validation of the Developed Materials

Range Interval	Descriptive Rating
4.20 – 5.00	Strongly Agree
3.40 – 4.19	Agree
2.60 – 3.39	Slightly Agree
1.80 – 2.59	Disagree
1.00 – 1.79	Strongly Disagree

The interactive e-learning resources in Science 5 were created using the ADDIE Model, a well-known instructional design methodology that stands for Analysis, Design, Development, Implementation, and Evaluation. This model provides a planned and methodical way to developing effective educational resources that are suited to learners' needs.

During the **Analysis** phase, the study began by identifying the educational needs and learning gaps among Grade 5 learners. A Needs Assessment Survey was conducted to determine the most challenging Science concepts, with a particular focus on the first quarter of the academic school year. In addition to the survey, a comprehensive review of existing Science 5 modules and instructional materials was carried out to evaluate the current content and teaching methodologies.

In the **Design** phase, the data gathered from the analysis informed the planning and structure of the interactive e-learning materials. A detailed blueprint was developed, outlining the content, instructional strategies, and interactive elements to be included. The interactive materials developed included the following lessons: Recognizing Useful and Harmful Materials; How Materials Change When Applied with Heat; and How Can We Manage Our Waste: The 5Rs Technique.

The **Development** phase involved the actual creation of the e-learning materials based on the design blueprint. This included the integration of interactive components such as quizzes and simulations that aligned with the identified learning needs.

Feedback from educational experts was sought during the **Implementation phase** to review and refine the materials, ensuring that they were both pedagogically sound and engaging. 10 validators with diverse expertise in education were selected to ensure a comprehensive assessment of the e-learning materials.

In the **Evaluation** phase, the effectiveness of the developed materials was assessed. Data from expert validations were analyzed to identify strengths and areas for improvement. Based on the evaluation findings, necessary revisions were made to enhance the quality and usability of the e-learning materials.

Through the systematic application of the ADDIE Model, this study ensured a comprehensive approach to developing and validating localized, interactive e-learning materials in Science 5, with the ultimate goal of improving student understanding and engagement in key scientific concepts.

The data that that were gathered were tallied and the frequencies were counted, tabulated, analyzed, and interpreted. Specifically, mean and standard deviation were utilized to analyze the rating given by the experts.

RESULTS AND DISCUSSION

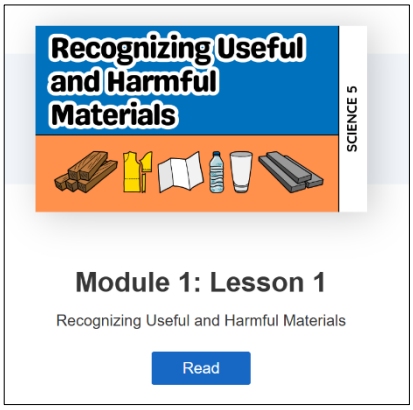
Interactive e-learning Materials in Science 5

The Interactive Electronic Learning Materials were developed based on identified most essential competencies for Science 5. An interactive electronic learning material refers to a digital learning resource that engages students actively with the content, utilizing various multimedia elements such as videos, quizzes, and simulations to enhance the educational experience. These materials allow learners to engage with the material in a hands-on manner, promoting deeper understanding and retention of scientific concepts. The developed interactive e-learning material encompasses a comprehensive structure consisting of seven key sections designed to facilitate effective learning through an interactive module.

Figure 1. The developed Interactive e-learning materials in Science 5.

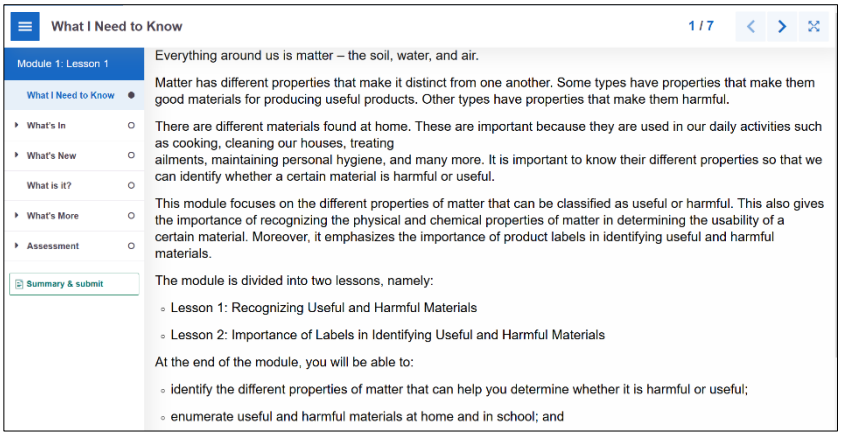
The interactive e-learning material begins with the **"Title Page"**, which introduces the content and sets the context for learners. It was designed to be visually appealing and informative, serving as the first impression of the educational resource.

Figure 2. Title Page



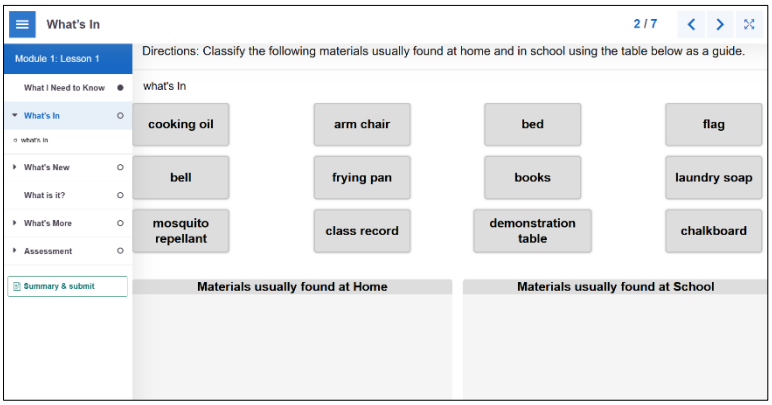
Following the Title page is the **"What I Need to Know"** section. This section outlines the objectives and key concepts, preparing students for the information they will encounter. It is crafted to provide learners with a structured overview of the crucial knowledge and skills they will develop throughout the lessons and establishes a clear roadmap for students, connecting their prior knowledge to new concepts while fostering critical thinking. but also highlights the relevance and practicality of the subject matter in their everyday lives. Overall, it not only prepares learners for the content ahead.

Figure 3. What I need to Know



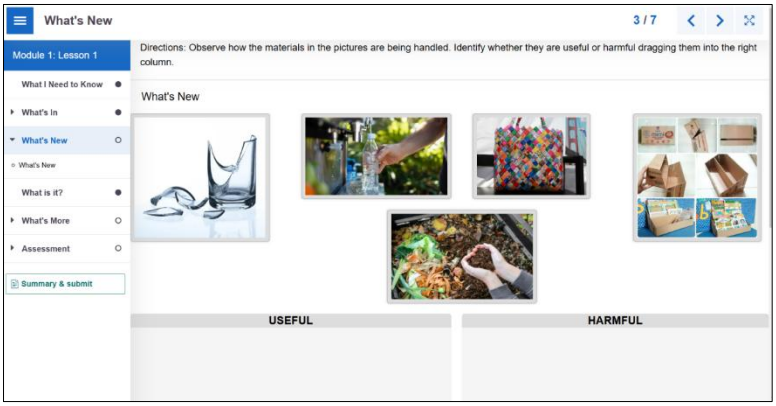
The **"What's In"** segment is designed to help learners review their prior knowledge, effectively connecting their existing understanding to the new material they will explore. This brief recap serves as a valuable bridge, facilitating a seamless link between the current lesson and the previous one, thereby reinforcing learning and promoting better comprehension of the upcoming concepts.

Figure 4. What's In



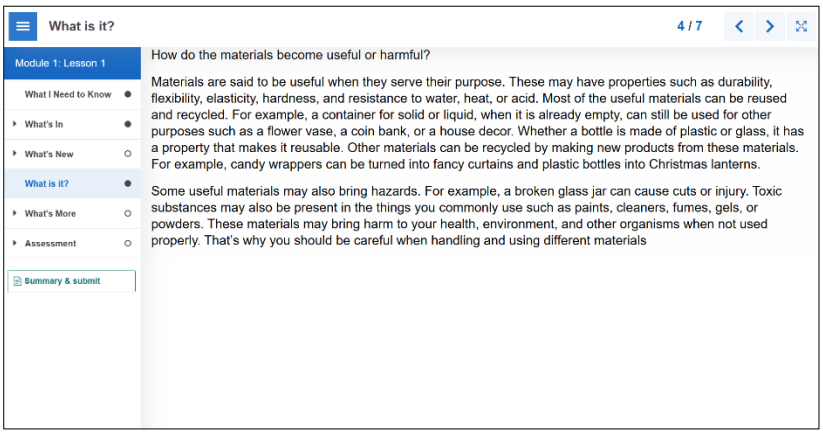
The **"What's New"** section introduces new ideas and topics in a fun way, using interesting stories and questions that encourage students to think and be curious. By using different methods to present the lesson, this section makes sure learners are not just watching but also getting involved in the learning process. Whether it's through everyday examples related to their lives or interactive talks that make them think hard, this approach helps create a lively and exciting learning space. This mix of activities not only keeps students interested but also helps them connect with the material better, leading to a deeper understanding of the topic being taught.

Figure 5. What's New



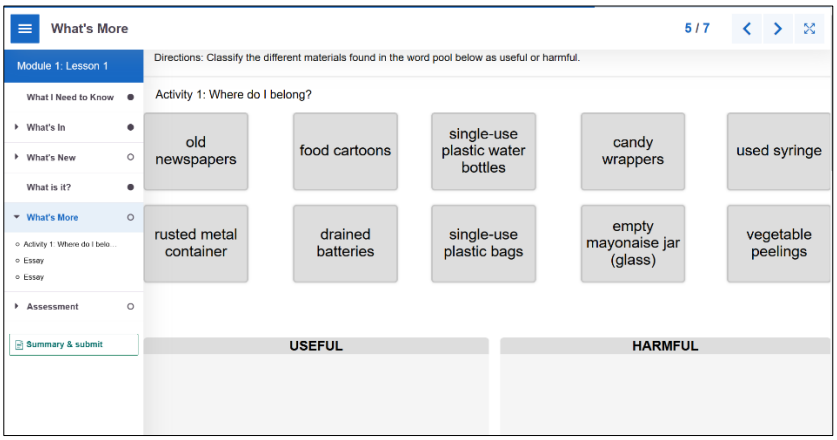
The **"What Is It"** section offers comprehensive explanations of essential concepts, seamlessly weaving together definitions and illustrative examples to significantly enhance learners' grasp of the topic. This section provides a thoughtful discussion of the lesson's core ideas, aiming to support learners as they navigate new concepts and develop vital skills. By breaking down complex information into accessible parts, it helps learners build a solid foundation that promotes deeper understanding and encourages the application of knowledge in various contexts. Ultimately, this thorough exploration equips students with the tools they need to engage more meaningfully with the subject matter.

Figure 6. What Is It



The **"What's More"** segment goes beyond the basic ideas introduced earlier by introducing real-life applications and engaging activities that encourage learners to think critically and gain a deeper understanding of the subject. This part is designed to connect what students have learned to everyday situations, helping them see how these concepts are relevant in the real world. Additionally, it includes various activities that allow students to practice on their own, reinforcing their understanding and skills related to the topic. By providing these opportunities for independent practice, the "What's More" section ensures that learners can solidify their knowledge and become more confident and capable in using what they have learned.

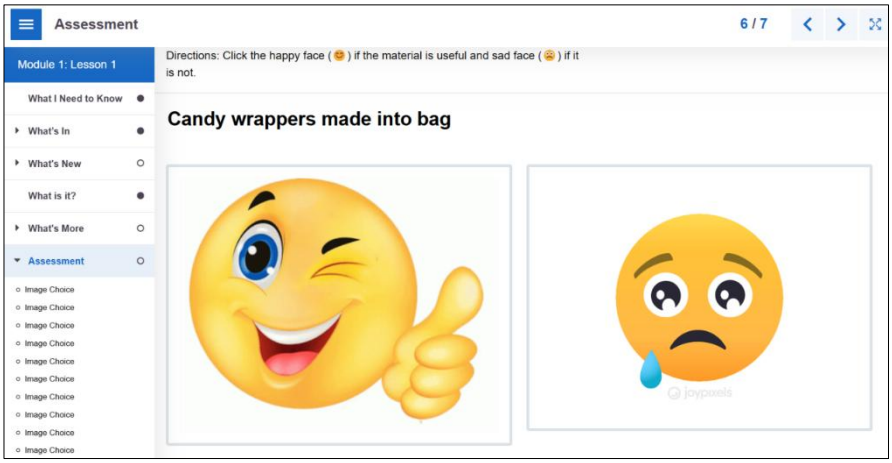
Figure 7. What's More



Lastly, the Assessment section evaluates learners' comprehension through various assessment formats, such as quizzes and interactive activities, offering immediate feedback to support ongoing learning.

Collectively, these sections create a structured and engaging e-learning experience that emphasizes active participation, catering to diverse learning styles and ultimately fostering a deeper understanding of the material. Figure 2 shows the interactive e-learning materials in science 5.

Figure 8. Assessment



Evaluation Rating of Teacher Experts on the Developed e-Learning Materials

The study also focuses on assessing the materials across three critical dimensions: Learning Environment, Teaching-Learning Process, and Learning Assessment. By examining the alignment of these materials with an optimal learning environment, the review ensures that they promote accessibility, inclusivity, and engagement. The evaluation of the teaching-learning process guarantees that the materials facilitate effective knowledge transfer, encourage active participation, and cater to diverse learning styles. Lastly, the focus on learning assessment ensures that the materials provide robust mechanisms to measure and enhance learner outcomes, supporting meaningful and measurable academic progress. This holistic evaluation ensures the e-learning materials meet the highest standards of educational excellence. Table 3 shows the evaluation rating of teacher experts on the e-learning material.

Table 3. Evaluation Rating of Teacher Experts on the Developed e-Learning Materials.

DOMAINS	MEAN	DESCRIPTIVE RATING
A. LEARNING ENVIRONMENT		
1. The user interface design of the e-learning materials is of high quality.	4.50	Strongly Agree
2. The e-learning materials are intuitive and easy to navigate.	4.80	Strongly Agree
3. The e-learning materials support a comfortable learning environment in terms of aesthetics and readability.	4.20	Strongly Agree
4. The e-learning materials are accessible for individuals with disabilities.	4.40	Strongly Agree
5. The visual design (e.g., color schemes, graphics) enhances the learning experience.	4.30	Strongly Agree
6. The e-learning materials load quickly and perform well technically.	4.40	Strongly Agree

7. The layout and organization of the e-learning materials are logical and user-friendly.	4.60	Strongly Agree
8. The e-learning materials are compatible with various devices (e.g., PC, tablet, mobile).	4.40	Strongly Agree
9. The multimedia elements (e.g., images, videos) are of high quality and contribute to the learning experience.	4.60	Strongly Agree
10. The e-learning materials provide adequate support and resources (e.g., help sections, tutorials).	4.60	Strongly Agree
MEAN SCORE	**4.48**	**Strongly Agree**
B. TEACHING-LEARNING PROCESS		
1. The e-learning materials present the content effectively.	4.40	Strongly Agree
2. The interactive elements of the e-learning materials (e.g., videos, quizzes, simulations) are engaging.	4.50	Strongly Agree
3. The e-learning materials facilitate understanding and retention of the subject matter.	4.60	Strongly Agree
4. The e-learning materials encourage student participation and interaction effectively.	4.40	Strongly Agree
5. The e-learning materials provide opportunities for critical thinking and problem-solving.	4.30	Strongly Agree
6. The instructions and guidelines provided in the e-learning materials are clear and concise.	4.20	Strongly Agree
7. The e-learning materials include real-world examples and applications.	4.30	Strongly Agree
8. The pacing of the e-learning materials is appropriate for the intended audience.	4.20	Strongly Agree
9. The e-learning materials provide opportunities for self-paced learning.	4.40	Strongly Agree
10. The e-learning materials are structured in a way that builds on previous knowledge effectively.	4.60	Strongly Agree
MEAN SCORE	**4.39**	**Strongly Agree**
C. LEARNING ASSESSMENT		
1. The assessment criteria used in the e-learning materials are clear and fair.	4.50	Strongly Agree

2. The assessments in the e-learning materials measure the learning objectives effectively.	4.60	Strongly Agree
3. The feedback provided through the assessments is timely and useful.	4.50	Strongly Agree
4. The assessment methods in the e-learning materials (e.g., quizzes, assignments, projects) are diverse and varied.	4.50	Strongly Agree
5. The assessments are appropriately challenging for the intended audience.	4.50	Strongly Agree
6. The assessments provide opportunities for applying learned knowledge.	4.50	Strongly Agree
7. The e-learning materials include formative assessments (e.g., practice quizzes) to monitor learning progress.	4.70	Strongly Agree
8. The summative assessments (e.g., final exams, projects) accurately reflect the learning outcomes.	4.70	Strongly Agree
9. The assessments are integrated seamlessly into the e-learning materials.	4.50	Strongly Agree
10. The assessments allow for self-assessment and reflection on learning progress.	4.60	Strongly Agree
MEAN SCORE	**4.56**	**Strongly Agree**
OVERALL MEAN SCORE	**4.48**	**Strongly Agree**

The evaluation of the e-learning materials along the Learning Environment dimension yielded a strong mean score of 4.48, categorized as "Strongly Agree." Notable strengths included intuitiveness and ease of navigation (4.80), logical organization and multimedia quality (4.60), and inclusivity through accessibility (4.40) and device compatibility (4.40). The user interface was rated positively at 4.50, while technical performance also received a commendable score of 4.40. Although aesthetics and readability scored slightly lower at 4.20, they still indicated strong agreement, suggesting room for improvement. Overall, the findings affirm the materials' effectiveness in supporting diverse learners and promoting engagement, with potential enhancements in aesthetics and readability further boosting their impact.

The evaluation of the e-learning materials along the Teaching-Learning Process dimension achieved an overall mean score of 4.39, classified as "Strongly Agree." Key strengths included facilitation of understanding and retention (4.60) and effective structuring to build on prior knowledge (4.60). Interactive elements received a score of 4.50, highlighting student engagement, while self-paced learning and interaction scored 4.40. Opportunities for critical thinking and real-world applications were valued at 4.30. However, clarity of instructions and pacing received a slightly lower score of 4.20, indicating potential areas for improvement. Overall, the findings confirm the materials' effectiveness

in promoting understanding and engagement, with some aspects needing refinement for enhanced learner support.

The evaluation of the e-learning materials along the Learning Assessment domain resulted in a strong overall mean score of 4.56, labeled as "Strongly Agree." High ratings were given for the inclusion of formative assessments and alignment of summative assessments with learning outcomes, both at 4.70. Other notable scores included clarity and fairness of assessment criteria (4.50), timeliness and usefulness of feedback (4.50), and a diversity of assessment methods (4.50). The assessments effectively facilitated self-assessment (4.60) and aligned with learning objectives (4.60), highlighting their role in promoting learner autonomy. Overall, the findings underscore the effectiveness and practicality of the assessments in supporting educational goals.

These findings align with contemporary educational technology research, such as the study by Hasmizan et al. (2025), which demonstrated the efficacy of gamified instructional tools developed through systematic design models like the Waterfall approach. Their Go Electronic game, aimed at digital electronics education, similarly enhanced student focus and engagement by integrating interactive, media-rich learning resources. Both studies underscore the importance of structured, iterative development models and contextually relevant digital instructional materials to address learning challenges and improve educational outcomes.

Table 4. Mean Score Rating of Teacher Experts on the Developed e-Learning Materials

Domains	Mean Scoore	Descriptive Rating
Learning Environment	4.48	Strongly Agree
Teaching-Learning	4.39	Strongly Agree
Process	4.56	Strongly Agree
Learning Assessment		
Overall	**4.48**	**Strongly Agree**

The table above indicates that the results have significant implications for the development of e-learning materials. The strong ratings across all indicators demonstrate that the assessments are not only well-designed and effective but also learner-centered and aligned with modern pedagogical practices. The focus on formative and summative assessments ensures a comprehensive evaluation of learner progress and outcomes. To maintain and further improve these strengths, regular updates and alignment with evolving educational needs can ensure sustained relevance and impact, making the e-learning materials a reliable tool for assessing and enhancing learning.

CONCLUSION

The findings of this study highlight the effectiveness and alignment of the developed e-learning materials with Grade 5 Science competencies, particularly in fostering student understanding and mastery of scientific concepts. Below are the key conclusions drawn:

1. Eight (8) interactive learning materials tailored for Grade 5 science education were developed and validated by experts.

2. The evaluation ratings from subject and instructional materials experts demonstrate that the e-learning materials meet high design and usability standards, achieving an overall mean score of 4.48 ("Strongly Agree"). They are easy to use, accessible, and engaging, effectively catering to a diverse audience, including individuals with disabilities.
3. The findings confirm that the developed e-learning materials effectively promote active participation, inclusivity, and meaningful learning through multimedia, interactive activities, and a learner-centered approach. Minor design improvements will enhance their educational value and wider applicability.

RECOMMENDATIONS

Based on the findings and evaluation of the developed interactive e-learning materials in Science 5, the following recommendations are proposed:

1. Future researchers should conduct pilot testing of the e-learning materials to gather insights on usability and engagement before widespread implementation.
2. Future developers should focus on creating more interactive and visually engaging e-learning materials by incorporating animations, simulations, and game activities to sustain learner interest and improve understanding of complex scientific concepts.
3. Training programs for Science teachers should include the effective integration of e-learning materials into classroom instruction, emphasizing the use of multimedia elements to enhance the teaching-learning process.
4. Adoption of developed interactive materials among Science teachers is encouraged to enhance their instructional practices.
5. Regular feedback from students, teachers, and IMs experts should be solicited to further refine the e-learning materials.
6. To maximize impact, the development of interactive e-learning materials should extend to other grade levels and subjects, fostering a comprehensive and modernized approach to education.

These recommendations aim to improve the quality, usability, and impact of interactive e-learning materials, ensuring their alignment with Grade 5 Science competencies and overall instructional goals.

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