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Quality Assessment of Digitized Instructional Material in Teaching Projectile Motion

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Abstract

This is study designed and developed a digitized instructional material for projectile motion and determined the level of expert evaluation of the material in terms of content quality, instructional quality, and technical quality. This study employed a descriptive-developmental research design to develop, validate, and refine digitized instructional materials for teaching projectile motion in Senior High School Physics. The descriptive component involved a needs assessment to identify learner characteristics, instructional gaps, and classroom context, ensuring alignment with curriculum standards and learning objectives. The developmental component focused on the systematic design, improvement, and validation of the instructional materials through iterative feedback. The study was conducted at Agusan National High School, Butuan City, with 40 Grade 12 students from an intact class selected through purposive sampling. Data were gathered using a researcher-made student questionnaire measuring engagement, usability, motivation, and learning support, and an expert validation instrument assessing content accuracy, instructional design, technical quality, and usability. Content and face validity were established through evaluation by five Master Teachers in Science. Data were analyzed using descriptive statistics, including frequency counts, percentages, and weighted means, interpreted using DepEd-aligned rating scales. The findings showed that the digitized instructional materials were rated Effective to Very Effective, with overall weighted means ranging from 4.43 to 4.67. Relevance and contextualization and validity and feedback obtained the highest overall weighted means (WM = 4.67), indicating strong curriculum alignment, meaningful real-life integration, and a credible validation process. Pedagogical effectiveness recorded an overall weighted mean of 4.54, highlighting the effectiveness of simulations and demonstrations in visualizing abstract projectile motion concepts. Content accuracy and completeness obtained a weighted mean of 4.49, showing adequate coverage of key concepts, though explicit treatment of misconceptions required enhancement. Usability and technical quality received the lowest overall weighted mean (4.43), pointing to minor concerns related to navigation and instructional sequencing. Overall, the results indicated that the digitized instructional materials were instructionally sound, curriculum-aligned, and pedagogically effective, with identified areas for refinement to further improve instructional quality.

Keywords: Digitized Instructional Materials, Content Accuracy, Instructional Design

1. Introduction

Projectile motion has long been regarded as one of the most challenging topics in physics because it requires learners to analyze two independent motions occurring simultaneously: horizontal motion with constant velocity and vertical motion with constant acceleration due to gravity (Serway & Jewett, 2018) [8]. Although many students are able to apply the correct formulae in solving numerical problems, they often struggle to explain the underlying principles of motion, particularly why gravity affects only the vertical component. This disconnect between procedural competence and conceptual understanding has resulted in persistent misconceptions, emphasizing the need for instructional materials that promote meaningful learning rather than rote memorization (McDermott, Rosenquist, & van Zee, 1987) [7].

In today's technology-driven and globally connected society, education systems have increasingly integrated digital technologies to enhance accessibility, learner engagement, and instructional effectiveness. This shift is especially evident in science, technology, engineering, and mathematics (STEM) education, where abstract and complex concepts benefit from interactive and visual representations that traditional teaching approaches may not adequately provide (Mayer, 2020) [6]. Digital instructional materials offer opportunities for learners to visualize motion, manipulate variables, and develop deeper conceptual understanding, which are critical in physics learning.

In the Philippines, the Department of Education (DepEd) has actively promoted the integration of information and communication technologies (ICT) into the K–12 curriculum to improve science instruction and strengthen digital literacy among learners (Department of Education, 2020) [2]. Despite these initiatives, challenges remain in effectively teaching complex physics topics such as projectile motion. Traditional instructional practices that emphasize equation-based problem-solving have often led students to memorize formulas without fully understanding the physical concepts involved, limiting their ability to apply knowledge to real-world situations (Hestenes, Wells, & Swackhamer, 1992) [3].

The development and validation of instructional materials are aligned with ongoing curriculum reforms and quality assurance efforts in the K–12 program. The implementation of flexible and distance learning modalities, particularly during the COVID-19 pandemic, further highlighted the need for high-quality, research-based, and responsive learning resources. Department of Education Order No. 18, s. 2020, issued under the Basic Education Learning Continuity Plan (BE-LCP), emphasized that learning materials must be aligned with the Most Essential Learning Competencies (MELCs) and must be accurate, instructionally sound, and technically reliable across different learning modalities (Department of Education, 2020) [2].

At Agusan National High School, projectile motion has been identified by physics teachers as one of the most difficult topics for students to master. Classroom observations and teacher assessments revealed that learners experienced difficulties in interpreting motion graphs, decomposing vectors, and understanding key concepts such as time of flight, range, and maximum height. These difficulties reflected not only computational errors but also deep-seated conceptual misunderstandings, consistent with findings in physics education research (McDermott *et al*., 1987) [7]. The lack of specialized and validated instructional materials, coupled with teaching approaches that relied heavily on procedural computation, further contributed to students' misconceptions.

Additionally, the assignment of physics subjects to teachers whose academic specialization was not in physics posed further instructional challenges. Limited content mastery often constrained teachers' ability to address misconceptions and explain abstract concepts effectively, resulting in instruction that focused primarily on procedural problem-solving rather than conceptual understanding (DepEd, 2020) [2]. Under these conditions, both teachers and learners were disadvantaged by the absence of high-quality instructional support. Hence, there is a clear need to assess the quality of digitized instructional materials through expert evaluation to ensure that they meet established standards in content accuracy, instructional effectiveness, and technical quality. Such quality assessment is essential to determine the suitability of digitized instructional materials as effective tools for improving physics instruction and learning outcomes...

2. Theoretical Framework

The theoretical framework of the study was based on John Sweller's Cognitive Load Theory (CLT), which was first proposed in 1988. It explains learning in relation to the limited capacity of working memory and the role of instructional design in facilitating effective learning. The theory is highly relevant to this research study, as the topic of projectile motion involves the simultaneous application of multiple concepts, including vector components, kinematic formulas, graphical analysis, and actual motion. It offers a theoretical foundation for explaining the learning difficulties faced by students in learning projectile motion and for designing learning materials to improve conceptual understanding.

CLT suggests that effective learning is achieved when learning materials are designed to manage the cognitive load imposed on learners during instruction. Sweller proposed that three types of cognitive load influence learning: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load. Effective instruction requires the reduction of unnecessary cognitive load while promoting productive cognitive processing that supports learning and knowledge development.

Intrinsic cognitive load refers to the natural complexity of the subject matter being learned. In the context of projectile motion, intrinsic complexity is high because of the need to understand the simultaneous interaction of horizontal and vertical motions, as well as the integration of vector analysis, motion equations, and graphical analysis. If these are not sequenced properly in instruction, the intrinsic complexity may exceed the working memory capacity of learners, resulting in misconceptions. In this research study, principles of CLT were applied by breaking down concepts of projectile motion into smaller learning segments. Topics such as projectile trajectory, vector analysis, and motion equations were sequenced in a manner that facilitated the processing of information in smaller chunks.

Extraneous cognitive load is associated with the presentation of information. Informationally, poor explanations, too much textual information, and confusing graphics contribute to excessive cognitive load that can hinder learning. To counter this problem, the digital instructional package created for the study was designed with a focus on clarity, coherence, and visual support. Superfluous textual information was kept to a minimum, and dynamic animations of projectile motion, interactive vector graphics, and well-labeled graphs of variables such as time, height, and range were highlighted. These aspects of the design reduced cognitive load associated with poor presentation and facilitated learners' understanding of abstract physics concepts (Mayer, 2020) [6].

Germane cognitive load is associated with the mental processing involved in organizing information and creating meaningful knowledge structures. This type of cognitive processing is critical for effective and long-lasting learning. In the study, germane cognitive processing was encouraged through interactive simulations that allowed learners to explore the impact of variables such as launch angle and initial velocity. Virtual experiments revealed the independence of horizontal and vertical motions, and guided problem-solving activities encouraged analytical thinking and integration of concepts.

3. Problem Formulation

This study designed, developed, and evaluated a digitized instructional material for teaching projectile motion. Specifically, it sought to design and develop a digitized instructional material for projectile motion and to determine the level of expert evaluation of the material in terms of content quality, instructional quality, and technical quality.

4. Significance of the Study

This study is significant to Grade 12 students, as the use of engaging and interactive digitized instructional materials enhanced their understanding of projectile motion concepts. It also contributes to the Department of Education by providing evidence-based support for addressing least learned competencies identified through Mean Percentage Score (MPS) results and promoting learner-centered instructional strategies. The findings benefit physics teachers by providing validated, curriculum-aligned digital resources that support the teaching of complex physics concepts through interactive and multimedia-based instruction. School administrators may use the results as a basis for adopting or replicating similar research-based instructional interventions across sections or schools. Curriculum planners are provided with a model for integrating digitally enhanced, theory-informed instructional materials into science curricula. Lastly, the study serves as a useful reference for future researchers in the development of innovative instructional designs for teaching challenging physics concepts such as projectile motion.

5. Scope and Limitations

This study developed and validated digitized instructional materials that were specifically designed to teach projectile motion to Agusan National High School, Butuan City. It also aimed at producing materials which would address the least learned competencies like Relative Velocity of 1D and 2D, Independence of vertical and horizontal components of the motion, and calculate time, height and range, identified in the second quarter. Investigation was limited to a sample of 40 students 16 females and 24 males from Grade 12 Section Dalton for the school year 2025–2026.

6. Methodology

This study employed a descriptive-developmental research design to develop, validate, and refine digitized instructional materials for teaching projectile motion in Senior High School Physics. The descriptive component involved a needs assessment to identify learner characteristics, instructional gaps, and classroom context, ensuring alignment with curriculum standards and learning objectives. The developmental component focused on the systematic design, improvement, and validation of the instructional materials through iterative feedback from experts and students.

The study was conducted at Agusan National High School, Butuan City. Participants consisted of 40 Grade 12 students from an intact class (Section Dalton), selected through purposive sampling because projectile motion was part of their Physics curriculum. The class composition included 60% female and 40% male students.

Data were collected using a researcher-made questionnaire that measured students’ perceptions of engagement, usability, motivation, and learning support after using the digitized instructional materials. A separate expert validation instrument was used to evaluate content accuracy, instructional design, technical quality, and usability. Content and face validity were established through review by five Master Teachers in Science, and revisions were made based on their consolidated feedback.

The instructional materials were implemented during regular Physics classes over a four-week period. Following implementation, student questionnaires were administered, and expert evaluations were completed. Data were analyzed using descriptive statistics, including frequency counts, percentages, and weighted means. Results were interpreted using predefined DepEd-aligned rating scales to determine levels of appreciation and effectiveness of the digitized instructional materials.

7. Results and Discussion

This section presents the expert's evaluation of the digitized instructional materials in terms of content quality, instructional quality, technical quality, and other findings

Table 2 presents the experts’ assessment of the digitized instructional materials on projectile motion based on five criteria: relevance and contextualization, validity and feedback, pedagogical effectiveness, content accuracy and completeness, and usability and technical quality. The presentation of findings for each criterion begins with the highest-rated indicator, followed by the lowest-rated indicator, and concludes with the overall weighted mean and supporting research insights.

Relevance and Contextualization

The highest-rated indicator under relevance and contextualization was the alignment of the content with curriculum standards and learning objectives, which obtained a weighted mean of 4.87, interpreted as Very Effective. Experts strongly agreed that the instructional materials were well aligned with the prescribed competencies on projectile motion.

This finding supports the study of Ahmed and Khan (2025) [1], which emphasized that strong curriculum alignment ensures instructional coherence and enhances learner understanding. The lowest-rated indicator in this criterion was the presentation of lessons through meaningful real-life contexts, although it still received a high weighted mean of 4.73, interpreted as Very Effective. Experts noted that the use of applications in sports and engineering helped learners connect abstract concepts to real-life situations.

Table 1: Experts Evaluation of the Digitized Instructional Materials

Indicators	Wtd Mean	Verbal Description	Interpretation
Content Accuracy and Completeness			
1. The material present the principles of projectile motion (independence of horizontal and vertical motion, …	4.40	Agree	Effective
2. The material cover key concepts like time of flight, range, maximum height, and the influence of initial velocity and.	4.67	Strongly agree	Very effective
3. Effective materials actively address and correct common student misunderstandings about projectile motion	4.40	Agree	Effective
Overall Weighted mean	4.49	Agree	Effective
Pedagogical Effectiveness			
1. The text and explanations be easy for the target grade level to understand, using appropriate language and avoiding overly complex jargon	4.60	Agree	Effective
2. Does the material use a variety of methods to keep students interested? This can include: • **Simulations and Demonstrations:** Tools that allow students to visualize or interact with the concepts.	4.80	Strongly agree	Very effective
• **Activities and Problem-Solving:** Exercises that encourage students to apply what they've learned and practice solving problems.	4.60	Agree	Effective
• **Real-world Context:** Showing how projectile motion applies to everyday situations to make the topic more relevant	4.47	Agree	Effective
3. The material have a clear and progressive flow, building from basic concepts to more complex applications.	4.33	Agree	Effective
Overall Weighted Mean	4.54	Agree	Effective
Relevance and Contextualization			
1. The content align with the specified learning objectives and curriculum standards for projectile motion	4.87	Strongly agree	Very effective
2. Presenting the lesson in meaningful real-life contexts makes the material more relevant and easier for students to connect with.	4.73	Strongly agree	Very effective
Overall Weighted Mean	4.67	Strongly agree	Very effective
Usability and Technical Quality			
1. The material is a physical tool or digital resource; it be easy to use and navigate	4.33	Agree	Effective
2. The materials function correctly without technical glitches	4.53	Strongly agree	Very effective
Overall Weighted Mean	4.43	Agree	Effective
Validity and Feedback			
1. Have the materials been reviewed by subject matter experts and educators to ensure the scientific accuracy and …	4.60	Strongly agree	Very effective
2. Incorporate student feedback after they use the materials to identify areas for improvement	4.73	Strongly agree	Very effective
Overall Weighted Men	4.67	Strongly agree	Very effective

Legend:1.00-1.49-Strongly disagree/ Not effective; 1.50-2.49-Disagree-Som4.67what effective; 2.50-3.49-Not certain/Moderately effective; 3.50-4.49-Agree/Effective; 4.50-5.00 Strongly agree/Very effective

Discussion

This finding supports the study of Tran and Lee (2024) [9], who found that contextualized instruction improves learners' ability to relate physics concepts to everyday experiences.

Overall, relevance and contextualization obtained an overall weighted mean of 4.67, indicating that the instructional materials were Very Effective in ensuring curricular relevance and meaningful learning.

Validity and Feedback

For validity and feedback, the highest mean was recorded for the indicator on incorporating student feedback during material development, with a weighted mean of 4.73, interpreted as Very Effective. Experts agreed that learner feedback was effectively used to refine the materials.

This finding supports the study of Lu *et al*. (2025) [5], which highlighted the importance of iterative feedback in improving the quality and effectiveness of digitized instructional resources.

The lowest-rated indicator was expert review for scientific accuracy, which still received a high weighted mean of 4.60, interpreted as Very Effective. This indicates that subject-matter experts confirmed the accuracy and appropriateness of the physics content. This finding supports the study of Lu *et al*. (2025) [5], which emphasized that expert validation is essential in ensuring content credibility and instructional reliability. Overall, the validity and feedback criterion yielded an overall weighted mean of 4.67, indicating a Very Effective validation process.

Pedagogical Effectiveness

Under pedagogical effectiveness, the highest-rated indicator was the use of simulations and demonstrations, which obtained a weighted mean of 4.80, interpreted as Very Effective. Experts emphasized that these tools effectively visualized abstract concepts in projectile motion.This finding supports the study of Jaafar, Ali, and Mahmod (2024) [4], which found that interactive simulations significantly enhance conceptual understanding in science learning.

The lowest-rated indicator was the progressive flow of concepts from basic to complex, which obtained a weighted mean of 4.33, interpreted as Effective. Experts suggested improving transitions between introductory concepts and advanced applications, leading to revisions in lesson sequencing and the addition of guiding prompts.This finding supports the study of Yip and Chua (2024) [10], which emphasized that clear instructional sequencing is crucial in teaching abstract scientific concepts.

Overall, pedagogical effectiveness recorded an overall weighted mean of 4.54, indicating that the materials were Effective in supporting student learning.

Content Accuracy and Completeness

For content accuracy and completeness, the highest-rated indicator was the coverage of key projectile motion concepts such as time of flight, range, and maximum height, with a weighted mean of 4.67, interpreted as Very Effective. Experts agreed that the essential topics were adequately addressed.

This finding supports the study of Ahmed and Khan (2025) [1], which highlighted the importance of comprehensive content coverage in physics instruction.

The lowest-rated indicators were the explicit treatment of fundamental principles and the correction of common misconceptions, both receiving a weighted mean of 4.40, interpreted as Effective. Experts noted that misconceptions, particularly the independence of horizontal and vertical motion, needed stronger emphasis. Revisions were made by adding explanatory notes and illustrative examples. This finding supports the study of Ahmed and Khan (2025) [1], which stressed the need to explicitly address misconceptions to deepen conceptual understanding. Overall, content accuracy and completeness obtained an overall weighted mean of 4.49, indicating that the materials were Effective.

Usability and Technical Quality

The highest-rated indicator under usability and technical quality was the absence of technical glitches, which obtained a weighted mean of 4.53, interpreted as Very Effective. Experts confirmed that the materials functioned reliably during use.

This finding supports the study of Lu *et al*. (2025) [5], which emphasized that technical reliability is fundamental to effective digital learning environments.

The lowest-rated indicator across all criteria was ease of navigation, which received a weighted mean of 4.33, interpreted as Effective. Experts reported minor issues related to navigation consistency and clarity of simulation controls. Interface improvements were implemented to address these concerns. This finding supports the study of Lu *et al*. (2025) [5], which highlighted usability as a key factor influencing learner engagement.

Overall, usability and technical quality yielded an overall weighted mean of 4.43, indicating that the materials were Effective. The expert evaluation showed that the digitized instructional materials on projectile motion were rated Effective to Very Effective across all criteria. Strengths were most evident in relevance, contextualization, and validation processes, while usability and instructional sequencing required refinement. Expert feedback directly guided revisions, demonstrating the importance of systematic validation in improving instructional design quality.

8. Conclusion

Based on the findings of the expert evaluation, the digitized instructional materials on projectile motion are effective to very effective in terms of relevance and contextualization, validity and feedback, pedagogical effectiveness, content accuracy and completeness, and usability and technical quality. The consistently high weighted means across all criteria indicate that the materials are well aligned with curriculum standards, grounded in sound pedagogical principles, and supported by a systematic validation process.

The strongest features of the instructional materials lie in their curricular alignment and meaningful contextualization, which enhance learners' ability to connect abstract physics concepts to real-life applications. The effective use of simulations and interactive elements further supports conceptual understanding, particularly in visualizing complex motion phenomena. These strengths demonstrate the potential of digitized instructional materials to improve the quality of physics instruction.

Although all criteria were rated positively, the findings also revealed areas requiring refinement, particularly in instructional sequencing, explicit treatment of common misconceptions, and ease of navigation. Addressing these areas through targeted revisions strengthened the instructional design without compromising content integrity.

9. Thank-You Note

The researcher would like to express sincere gratitude to the 40 Grade 12 students of Section Dalton from Agusan National High School, Butuan City, for their valuable participation in this study. Their willingness to share their time, effort, and honest responses greatly contributed to the successful completion of the research. The cooperation and enthusiasm shown by the participants made the data-gathering process meaningful and productive. This study would not have been possible without their support and involvement.

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