# DESIGNING INTERACTIVE SCIENCE LEARNING MATERIALS: A METHODOLOGY GUIDED BY THE ADDIE MODEL

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***ABSTRACT:*** *Amidst the ongoing pandemic, there has been a substantial surge in demand for virtual instructional materials. Many Filipino educators found themselves unprepared and without access to adequate tools for distance education. While some tools were available, the majority were outdated and in a state of disrepair. To address this issue effectively, it is crucial to adopt a systematic approach, such as the ADDIE Model. The ADDIE Model's stepwise process is of paramount importance, as the effectiveness of instructional material design is assessed through the results of evaluations and the realization of intended learning objectives. This study focuses on the development of virtual Science interactive learning materials designed for distance learning, adhering to the five key phases of the ADDIE Model. A formal assessment was conducted to evaluate the newly developed materials, examining their validity in terms of Content Quality, Instructional Quality, Technical Quality, and Technical Error. Additionally, the assessment aimed to gauge the usability and interoperability of these materials.*

**Keywords**: ADDIE, Developing Instructional Materials, Non-Print, Virtual Resources

## 1. INTRODUCTION:

The educational landscape has been profoundly reshaped by the transition to non-face-to-face learning precipitated by the global pandemic. Technology has emerged as an indispensable element within the educational framework, extending the reach of educational services beyond conventional classrooms into the digital domain. This digital pivot has proven to be particularly invaluable during the pandemic, affording educators the means to conduct virtual classes and sustain uninterrupted educational delivery. However, this transition has not been without its challenges, notably concerning issues such as subpar communication and limited accessibility. Nevertheless, investing in instructional technology is widely acknowledged as a viable solution for advancing education and enhancing academic outcomes. Hillmayr *et al*. [1] posit that such investments may hold the key to surmounting these challenges. Within the context of Philippine schools, the promotion of educational resources conducive to remote teaching and learning is actively encouraged. However, it is essential to acknowledge the hurdles encountered, including the scarcity of learning resources and limited internet access for certain learners and educators. This shift towards online instruction aims to rectify suboptimal academic performance but carries the unintended consequence of disproportionately affecting marginalized communities lacking access to essential technology [2, 1]. A substantial portion of Philippine students grapple with academic difficulties, which can be attributed to multiple factors, including inadequate instructional materials and classroom resources. In the field of Science, international assessments such as the Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS) have revealed the Philippines' subpar Science scores [3, 4]. Recognizing these challenges, the Department of Education is actively engaged in efforts to address disparities and issues in basic education. The enhancement of Science education among students holds particular significance and is a critical facet of the broader Quality Basic Educational Reform Strategy, coinciding with a broader globalization agenda aimed at raising the overall educational standards [5]. The introduction of non-face-to-face learning, initially expedited by the pandemic, is expected to gain further momentum in the post-pandemic era. Although this approach offers considerable advantages, it has inadvertently led to disparities in educational access, disproportionately affecting underserved communities. Consequently, stakeholders advocate for educational resources that support remote learning in the New Normal. While online instruction represents a path toward this objective, not all learners and educators possess internet access or high-speed connections, which poses challenges to the effectiveness of this mode of learning. Moreover, some educators continue to rely on traditional teaching methods that have been proven ineffective in addressing subpar learner performance [6]. In response to these challenges, the development of Virtual Science Interactive Learning Materials is underway, addressing the specific needs of the Emerging Normal education setup in the Philippines. This initiative underscores the importance of inclusive teaching and learning, bridging geographical and socioeconomic divides for educators and learners alike. Additionally, adapting to 21st-century Science education in this digital age equips younger students with the skills and expertise essential for future scientific pursuits [7].

## 2. RESEARCH OBJECTIVES:

This study aimed to develop Virtual Science Interactive Learning Materials for distance learning by the five steps of the ADDIE Model. Specifically, it sought to:

1. Determine the level of validity of the Virtual Science Interactive Learning Materials text in terms of:
   a. Content Quality;
   b. Instructional Quality;
   c. Technical Quality; and
   d. Technical Errors.
2. Evaluate the usability and interoperability of the Virtual Science Interactive Learning Materials.

### 2.1. Instructional Design Model

The ADDIE model is a framework whose name depicts the five steps in the model: Analysis, Design, Development, Implementation, and Evaluation. It was initially developed in the 1970s by the Center for Educational Technology at Florida State University. The model has been widely used in instructional design and training development, both in academic and corporate settings [8]. Several studies have examined the effectiveness of the ADDIE model in various contexts, such as healthcare, business, and education. For instance, research has shown that the model can improve learners' engagement, performance, and satisfaction [9, 10, 11, 12]. However, some scholars have criticized the ADDIE model for being too linear and rigid, as it may not account for the iterative and dynamic nature of the design process [13, 14]

### 2.2. Theoretical Framework

The interaction specifically in the learner-content applies the Principles of Transactional Distance [15]. According to Moore, the learner's perception of transactional distance is determined by dialog, structure, and learner autonomy. The Transactional Distance investigated how internal (lesson content) and external (contextual) structure components interact. This is related to the purpose of the non-print resources as a tool for Distance Education and how they influenced learner autonomy [16, 17].

**Table 1. Learning Domain Mastered in the Science Subject**

| Learning Domain | SY 2017-2018 | | | SY 2018-2019 | | | SY 2019-2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Pretest (%)* | *Posttest (%)* | *P-Value* | *Pretest (%)* | *Posttest (%)* | *P-Value* | *Pretest (%)* | *Posttest (%)* | *P-Value* |
| Matter | 44.062 (AVR) | 64.583 (AVR) | 0.0002* | 49.617 (AVR) | 68.087 (MTM) | 0.0000* | 37.559 (AVR) | 61.127 (AVR) | 0.0000* |
| Living Things and Their Environment | 48.125 (AVR) | 70.833 (MTM) | 0.0000* | 65.792 (MTM) | 76.503 (MTM) | 0.0002* | 47.887 (AVR) | 70.423 (MTM) | 0.0000* |
| Forces and Motion | 42.604 (AVR) | 63.229 (AVR) | 0.0002* | 40.437 (AVR) | 59.344 (AVR) | 0.0000* | 35.493 (AVR) | 64.789 (AVR) | 0.0000* |
| Earth and Space | 56.667 (AVR) | 80.312 (MTM) | 0.0000* | 60.328 (AVR) | 69.617 (MTM) | 0.0049* | 48.638 (AVR) | 74.836 (MTM) | 0.0000* |
| Weighted Average | 47.865 (AVR) | 69.740 (MTM) | 0.0000* | 54.043 (AVR) | 68.388 (MTM) | 0.0000* | 42.394 (AVR) | 67.793 (MTM) | 0.0000* |

Constructivism is a philosophy of curriculum and learning intended to optimize pupils' comprehension. Hobbiss [18], described it more as a learning philosophy that illustrates the active role played by students in constructing knowledge comprehension and meaning.

Constructivism is a theory of how learning occurs [19, 20, 21]. This perspective claims that people develop their social awareness and wisdom through reflection and self-assessment, even by witnessing and focusing on these occurrences [18, 22]. The development of self-paced instructional resources can promote autonomy in various ways [10, 23, 24].

The Theory of Media-Equivalence of Clark [25], explains that teaching using digital media's effectiveness is different from any other media. This presented the idea that external stimuli, representations, symbol systems, and media were peripheral to cognition and learning [26, 27]. This is a concept associated with a body of cognitive theory that has since been significantly changed [2]. According to Kariman, [28], effective technology multimedia integration in education changes classroom dynamics, this could encourage student-centered and project-based learning depending on how the multimedia is used. Stoltzfus and Libarkin, [29], also sought that traditional lectures are not fulfilling the learning perspective of typical students today. Although distance education and online courses are popular options for nontraditional learners, these cannot be expected to function effectively with the tech-savvy generation — The social factor, as well as, cognitive and other learning components, are still necessary, [7, 22]. As instructional innovation advances, an increasing number of students will demand that multimedia be included. Holmberg [30], established the Interaction and Communication Theory, which promotes more significant learning by establishing a synergy through didactic interactions. Since students merge new things, they encounter their initial ideas and practices. Throughout the analysis, the researchers have taken advantage of preceding knowledge on the knowledge area and directed learners to understand the subject through intervention materials created to achieve a better the topics that are too difficult to learn and master by themselves.

The didactic interactions relive the prior experience of the learner [31]. Effective virtual learning during the pandemic should prioritize context, connectivity, time, and personalization, as outlined in Crompton's [32], criteria for leveraging mobile opportunities. This approach should promote 21st-century competencies, including academic and technology literacies [33], and ensure high-quality education for all [28].

## 3. THEORETICAL FRAMEWORK:

The literature review findings were applied to the development of virtual science interactive learning materials by identifying best practices for creating effective and engaging educational content.

## 4. MATERIALS AND METHOD:

This study used the descriptive-development method using the ADDIE Model. In the Analysis Phase, the following were described before the development of the Virtual Science Interactive Learning Materials: (1) competency mastered by the students, (2) level of competence based on the Science Achievement Test results, and (3) Adequacy Rate and Status of non-print learning materials. (1)

There were four learning domains with targeted learning competencies to be addressed for Science 5 based on the analysis of the Achievement Test Results these topics are located in the Most Essential Learning Competencies (MELC), namely Matter for First Quarter, Living Things and Their Environment for the Second Quarter, Forces and Motion for the Third, and The Earth and Space for the Fourth Quarter. (2) Analyses of the Science Achievement Test results for three school years, from SY 2017-2018 to SY 2019-2020, were done to determine the level of competence of the Grade 5 level in the Science subject. Based on the data, the post-test scores showed a significant increase from the pre-test results. However, a closer examination of Science competency levels revealed that the competencies were hardly reaching Closely Approximating Mastery or Mastery The majority of students received Low Mastery to Average in most skills each year, with only a few Moving Towards

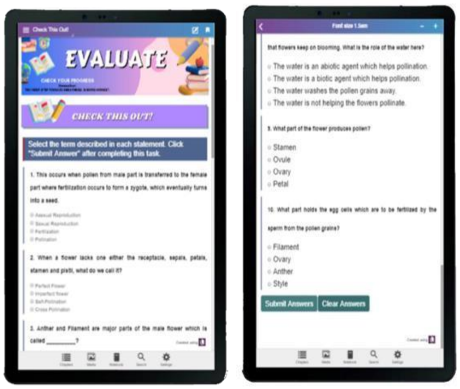


**Figure 1. Assessment Feature of Virtual Science 5**

Mastery, Closely Approaching, and Mastery (see Table 1). Paying attention to these nuances is critical for strategic initiatives to improve student performance in the domain. (3)

In determining the adequacy rate and status of non-print learning materials, a researcher-made questionnaire was developed and tested for validity and reliability. The overall response of the five expert evaluators about the tool was very valid for it generated a Median of 4. Furthermore, regarding Content, Organization, and Objectivity criteria, the median was Much Valid (Md=4). On the other hand, the Appropriateness and Sensitivity were Very Much Valid (Md=5). In addition, the questionnaire was pilot-tested among 20 Science teachers. The calculated Cronbach alpha value of the questionnaire items is 0.736, implying Adequate Reliability. As a result, the test questions' internal validity (consistency) was Strong. This indicated that the questions were consistent and they were interrelated. The analysis revealed that the digital interactive materials, both online and non-online, along with eBooks, were perceived as the three most adequate non-print learning materials by teacher-users (see Table 2). These resources were also the most frequently utilized for teaching and providing supplemental courses and activities (see Table 3). However, some non-print resources such as CDs, VCDs, DVDs,

VHS tapes, transparencies, slides, and cassette tapes have become obsolete, dilapidated, and underutilized, with some still available in schools but not being used by teachers.

In the Design Phase, structuring and designing of the instruction, learning strategies, assessment, and evaluation were included in this phase. Virtual Science 5 (VS5) is a mobile learning package designed to address the challenges of remote learning, methodologies, and the distance learning environment.

It was created as an electronic publishing (EPUB) platform to provide an innovative solution for students and teachers with low-bandwidth connections and can be accessed offline. Its instruction design was created in the 5E paradigm, which included the stages: Engage, Explore, Explain, Elaborate, and Evaluate. Each lesson began with a Self-check Activity to assess prior knowledge. The Engage Phase introduced short activities to engage students and connect their prior knowledge to new concepts. The Explore phase involved hands-on activities to deepen understanding. In the Explain phase, students used interactive pop-up elements to explain what they had learned.

In the Development Phase, this involved creating pop-up-based learning materials for virtual science education. It included searching and selecting appropriate data sources, creating content, illustrations, schemata, and graphs, typing and editing, and laying out the e-textbook. Additionally, the phase involved structuring and writing dialogues. The dialogues in each lesson invited students to click on interactive pop-ups that integrated supplementary texts, audio, and photos to enhance the topics, much like a typical hyperlink (Figure 3).

The VS5 lesson package was designed to be compatible with various devices, including Android and Apple IOS mobile phones, tablets, laptops, and desktop computers. However, an upgraded mobile or Windows system was required to fully experience the content, and an EPUB reader was necessary to view the files. The lessons were presented in EPUB format, which supported HTML for reflowable and interactive lessons. Moreover, the VS5 project included interactive digital files of lessons, each less than 20MB in size, with condensed audio and video content to maintain quality.

The project also featured auto-scored assessments with feedback and details about answers, including self-checks, quick checks, and formative tests. It includes offline and online-ready practical guides for parents and guardians, accessible in PDF and Google Site format. In the Implementation Phase, the VS5 prototype was introduced to fifty (50) Grade 5 students within a month timeframe scheduled manner. Lastly, in the Evaluation Phase, formative assessments were carried out to attain the main objective of this research. The VS5 was assessed by five (5) professional evaluators: two subject matter experts, two learning design experts, and one learning media expert. The evaluation tool used was the DepEd Evaluation Rating Sheet for Non-print Materials under LRMDS Assessment and Evaluation of Locally Developed and Procured Materials, [4]. Each category's score analysis was based on the minimum passing score.

- ❖ Content Quality- at least 30 points out of a maximum of 40 points
- ❖ Instructional Quality - at least 30 points out of a maximum of 40 points
- ❖ Technical Quality - at least 39 points out of a maximum of 52 points
- ❖ Technical Errors - at least 16 points out of a maximum of 16 points

Moreover, in the evaluation of VS5’s usability and interoperability, usability was presented as a percentage, while interoperability was reported in text form. These were based on a trial conducted by expert evaluators.

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The Validity Assessment of the Virtual Science Interactive Learning Materials, specifically the Virtual Science 5 (VS5), was determined through a scoring system. The criteria were scored, and each criterion's passing score determined the material's validity.

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**Table 2. Adequacy Rate of Non-Print Learning Resources**

| Non-Print Learning Resources | Inventory Frequency (material) | Adequate (%) | Inadequate (%) | Not Available (%) |
|---|---|---|---|---|
| Digital Interactives (Online) | 112 | 52.94 | 32.35 | 14.71 |
| Digital Interactives (Non-Online) | 109 | 52.94 | 29.41 | 17.65 |
| eBook | 33 | 35.29 | 35.29 | 29.41 |
| Transparencies | 6 | 11.76 | 26.47 | 61.76 |
| Slides (Transparent Photo) | 6 | 8.82 | 17.65 | 73.53 |
| CD | 32 | 5.88 | 35.29 | 58.82 |
| VCD | 18 | 2.94 | 20.59 | 76.47 |
| DVD | 14 | 0.00 | 29.41 | 70.59 |
| VHS | 11 | 0.00 | 26.47 | 73.53 |
| Cassette | 2 | 0.00 | 23.53 | 76.47 |

**Table 3. Status of Non-Print Learning Resources**

| Non-Print Learning Resources | Inventory Frequency (material) | Frequently Used (%) | Seldom Used (%) | Unused (%) | Dilapidated (%) | Obsolete (%) |
|---|---|---|---|---|---|---|
| Digital Interactives (Online) | 112 | 44.12 | 35.29 | 11.76 | 8.82 | 0 |
| Digital Interactives (Non-Online) | 109 | 41.18 | 26.47 | 23.53 | 8.82 | 0 |
| eBook | 33 | 23.53 | 20.59 | 38.23 | 5.88 | 11.76 |
| Transparencies | 6 | 0 | 11.76 | 26.47 | 17.65 | 44.12 |
| Slides (Transparent Photo) | 6 | 0 | 0 | 14.71 | 17.65 | 67.65 |
| CD | 32 | 0 | 17.65 | 32.35 | 5.88 | 44.12 |
| VCD | 18 | 0 | 2.94 | 32.35 | 11.77 | 52.94 |
| DVD | 14 | 0 | 5.88 | 35.29 | 8.82 | 50 |
| VHS | 11 | 0 | 0 | 23.53 | 11.76 | 64.71 |
| Cassette | 2 | 0 | 2.94 | 26.47 | 17.65 | 52.94 |


**Figure 2. Samples of localized and contextualized information in the materials**

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**Content Quality**

The VS5 demonstrated congruence with science subject Learning Competencies and Grade 5 level based on the score of 39 out of 40 points for Content Quality (Table 4). The material has adequate content and is free of bias, with factual, current, and logically produced information that reinforces defined learning objectives.

**Table 4. Evaluation of the Content Quality**

| Criteria | Mean |
|---|---|
| 1. Content is consistent with topics/skills found in the DepEd Learning Competencies for the subject and grade/year level it was intended. | 4.2 |
| 2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives. | 4.2 |
| 3. Content is accurate. | 4.2 |
| 4. Content is up-to-date. | 4.0 |
| 5. Content is logically developed and organized. | 3.6 |
| 6. Content is free from cultural, gender, racial, or ethnic bias. | 3.8 |
| 7. Content stimulates and promotes critical thinking. | 3.8 |
| 8. Content is relevant to real-life situations. | 3.6 |
| 9. Language (including vocabulary) is appropriate to the target user level. | 3.8 |
| 0. Content promotes positive values that support formative growth. | 3.8 |
| **Total** | **39** |

Based on the evaluation, the 5E model was structured well and easy to understand, stimulating critical thinking and real-world application. It considered technical language and strategies to clarify it, as well as positive value inclusions. The content aligns with Moore's Transactional Distance principles, prioritizing meaningful and constructive dialogue for improved comprehension.

## 5. RESULTS AND DISCUSSIONS:

### 5.1. Validity of the Virtual Science Interactive Learning Materials

Several factors contributed to the effectiveness of VS5 content, including its accuracy, consistency with DepEd Learning Competencies for the corresponding grade level, and its ability to enrich, reinforce, or master identified learning objectives. When it comes to creating educational materials, it was ensured that material developers aligned the lessons with the curriculum for the specific subject and grade/year level they were intended for. This helped ensure that the content was relevant and useful for students and that it contributed to their mastery of the identified learning objectives.

In constructivist teaching methods, teachers act as a "guide on the side," allowing students to evaluate their interpretations and understanding [18]. The 5E Model is based on constructivist learning theory, which suggests that learners form knowledge and understanding based on their experiences. Through comprehension and reflection on activities, students can reconcile new knowledge with past ideas, thereby developing their independence and wisdom [19]. In addition to accuracy and consistency, materials that are easy to understand and follow can be more effective in helping students learn.

Effective tools for teaching and learning must also be engaging can help to keep students interested and motivated to learn. To ensure effective learning, the contents should be structured to demonstrate the relevance of the topic to real-life situations and encourage critical thinking.

Additionally, it is important to use appropriate language and vocabulary for the intended user level. While the reading material is critical, students' engagement with the content plays a vital role in their comprehension [22].

**Instructional Quality**

The VS5 has been rated and scored based on its instructional quality, receiving a total of 37.4 points, surpassing the required 30 points out of 40 to satisfy this criterion (Table 5). This indicated that the instructional objective of the resource was clearly defined and well-integrated into the material. Moreover, it revealed that the materials were appropriately designed and effectively served their intended purpose. The learning objectives and expected student performances were evident, with various teaching levels made available. The content was arranged in logical chunks and sequences, and the time spent engaging with the material was proportionate to the outcomes obtained. The graphics, sound, and color were utilized neutrally in illustrations and visualizations, skillfully linking the figures and tables through modified dialogues. According to Transactional Distance Theory, courses with low transactional distance tend to benefit from interaction with an instructor through a loosely structured program that supports individual interactions [16]. In more distant programs like what had arisen during the pandemic, however, where dialogue is limited, such as using printed modular approaches, learning materials were structured to incorporate all the necessary assistance, guidance, and recommendations developers can provide, albeit without the potential for dialogue with a teacher to reconfigure the learning situation [17].

**Table 5. Evaluation of the Instruction Quality**

| Criteria | Mean |
|---|---|
| 1. The purpose of the material is well-defined. | 4.0 |
| 2. Material achieves its defined purpose. | 3.8 |
| 3. Learning objectives are clearly stated and measurable. | 4.0 |
| 4. The level of difficulty is appropriate for the intended target user. | 3.4 |
| 5. Graphics/colors/sounds are used for appropriate instructional reasons. | 3.4 |
| 6. Material is enjoyable, stimulating, challenging, and engaging. | 3.8 |
| 7. Material effectively stimulates the creativity of the target user. | 3.8 |
| 8. Feedback on target users' responses is effectively employed. | 3.8 |
| 9. Target users can control the rate and sequence of presentation and review. | 3.6 |
| 10. Instruction is integrated with the target user's previous experience. | 3.8 |
| **Total** | **37.4** |

To address this, the researchers adopted a progressive structure that scaffolded the students' comprehension. The design, presentation, and display of information through VS5 encouraged user participation, and relevant, immediate, and logical feedback was provided.

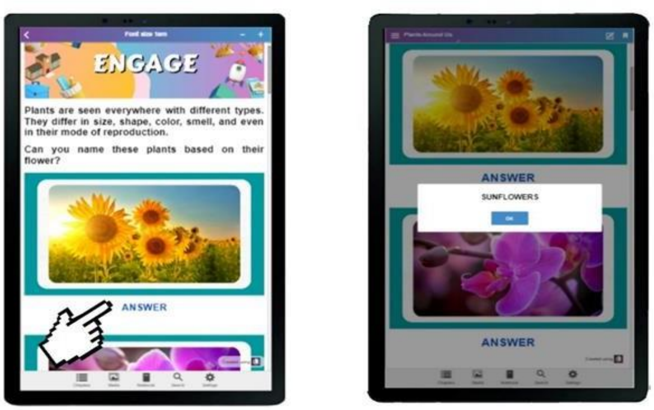


**Figure 3. Interactive Pop-up-based feature of VS5**

The instructions and questions were designed to eliminate confusion and provide precise knowledge, with each response prompt and helpful [18]. Access to numerous information and concept chunks was logical, and additional explanations of the interrelation of the learning chunks and the many pathways were provided [22, 24].

**Technical Quality**

Virtual Science 5 multimedia exceeded the technical quality score with a total of 48 points out of a maximum of 52, indicating its potential to improve knowledge and comprehension (Table 6). The material was visually appealing and easy to understand with clear voice-over, audio, video, and pictures that were in sync. The content used beneficial music and sound effects, pagination mechanisms, and restricted text on the screen. The Navigation page included clear directions and helpful user assistance resources, with suggestions to enhance the flow of pages with in-book hyperlinks. The content was developed with technical nuances and multimedia aspects that are crucial for cognition and learning. By the Theory of Media-Equivalence, technical nuances, and multimedia aspects [28], play a significant role, as they are essential to cognition and learning [29], despite being peripheral [2].

**Table 6. Evaluation of the Technical Quality**

| Criteria | Mean |
|---|---|
| 1. Audio enhances understanding of the concept. | 4.0 |
| 2. Speech and narration (correct pacing, intonation, and pronunciation) are clear and can be easily understood. | 3.6 |
| 3. There is complete synchronization of audio with the visuals if any. | 4.0 |
| 4. Music and sound effects are appropriate and effective for instructional purposes. | 3.8 |
| 5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing. | 3.4 |
| 6. Visual presentations (non-text) are clear and easy to interpret. | 3.8 |
| 7. Visuals sustain interest and do not distract the user's attention. | 3.8 |
| 8. Visuals provide an accurate representation of the concept discussed. | 3.8 |
| 9. The user support materials (if any) are effective. | 3.6 |
| 10. The design allows the target user to navigate freely through the material. | 3.8 |
| 11. The material can easily and independently be used. | 3.6 |
| 12. The material will run using minimum system requirements. | 3.6 |
| 13. The program is free from technical problems. | 3.2 |
| **Total** | **48** |

**Technical Error**

Table 7 shows that Virtual Science 5 scored the exact number of points needed to pass the criterion under the category of Technical Errors. This indicates that the presented information is correct and relevant, and any grammar mistakes, errors, out-of-date information, and visual flaws have been corrected to prevent misunderstandings or confusion.

**Table 7. Evaluation of Technical Errors**

| Criteria | Mean |
|---|---|
| 1. Conceptual errors. | 4 |
| 2. Factual errors. | 4 |
| 3. Grammatical and/or typographical errors. | 4 |
| 4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.). | 4 |
| **Total** | **16** |

## 5.2 Evaluation of Usability Characteristics Multimedia Design

The Multimedia Design garnered 92.50 percent (92.50%)

approval from the evaluators. This signifies that VS5's media elements were useful. Although there was room for improvement in terms of multimedia quality. However, using high-definition multimedia features needs more file storage, particularly for mobile phone users [27].

The layout's coherence has to be enhanced to accommodate the built-in functionality and all multimedia elements. Cognitive architecture and processing of information are fundamental in courses, most especially in difficult-to-understand lessons [2], thus instructional designers should consider multimedia design to direct students' knowledge acquisition and attention. The limited capacity of the learners' working memory has significant consequences for education, including how instructional materials should be designed [28].

**Overall Interface**

Ninety-six-point thirty-seven (96.37) percent (93.37%) satisfaction across all categories indicated that the material's interface is aesthetically appealing and consistent, user-friendly, and offers adequate information and guidance for usage. Improvements in terms of simplicity and consistency across successive displays are also necessary. Strategically planning and designing the whole interface entails satisfying the learners in the virtual world they will traverse [20, 21].

When a learner is unfamiliar with a topic, it might be difficult to appreciate its relativeness to them. As a result, instructional designers are encouraged to employ attentional signals to steer students' attention and mastery of the competency. According to Lim et al. [22], these signals aid in information selection and the structuring and integration of multiple components.

**Behavior of Controls & System Information**

There was a 100 percent (100%) approval of evaluators on the usability of Behavior of Controls and System Information. This implies that the controls and functionalities in VS5 respond effectively to the user's instruction/direction. Menus, buttons, and other commonly used controls have comparable forms and aesthetics, and their designs are suitable for their intended usage. Moore [15], outlined the importance of student-environment interaction or learners' seamless involvement with technology in providing more significant opportunities to focus on Learner-Content. Thus, behavioral control over technology should not be an overwhelming task for students because self-paced learning encourages students to devote time to domains where they are weak [10]. Thus, according to Osman and Chen [7], designing interactive instructional tools that satisfy the demands of students while also addressing the boundaries of the teaching and learning environment is a critical component of effective teaching.

**Customizability/Support for User Preferences**

The majority of the criteria offered received 97.14 percent (97.14%) acceptance from the evaluators. This implies that the functionalities of VS5 are usable and can be customized according to the specified pace desired by the users. The designers also considered the durability and good quality of the physical design, which is intended to create ideal learning experiences for all learners. Although VS5 is accessible to desktop and laptop computers that primarily require mouse devices, this was designed to satisfy the touch screen advantages of today's mobile technology while also increasing user enjoyment. Increased enjoyment of learning is more apparent with the customizability and assistance provided to learners because students change from the passive role of acquiring knowledge to the more active one of being seekers of knowledge [23].

**Data Entry by User**

The evaluators gave VS5 96.37 percent approval. This implies that the VS5's data entry fields and forms encourage user interaction, resulting in clear, guided navigation and a lower incidence of erroneous/missing data entries. A well-planned structural e-design and logical framework was required for good course organization and navigation. While there is no "perfect" approach to designing a course, there are other areas where the VS5 might be improved, such as the explicitness of when data should be entered and directions on the length of time necessary to submit the data. Instructional Designers, teachers, and facilitators must be thoughtful in their decisions and carry useful instruction throughout the whole course structure [24]. However, to reduce student dissatisfaction with interactive systems, teachers should be clear and transparent about their expectations, and offer opportunities for students to receive assistance [26].

**Hyperlinks**

The evaluators have unanimous approval of the usability of Hyperlinks. This demonstrated that the Hyperlink text contains relevant and helpful information on where the learners were directed by the hyperlinks. Furthermore, the hyperlinks are consistent and constructed by acceptable link formatting conventions. Since the hyperlink has been lauded for its potential to 'connect people and information,' linking to other multimedia as well as other references can aid in enhancing engagement and counter the cognitive distraction that hyperlinks can cause [16]. Furthermore, including other valuable and relevant resources. According to Nichols Hess and Greer [10], hyperlinks can expose learners to new information and show them different ways of thinking and learning.

**5.3. Evaluation of Interoperability: Technical Format**

The standards under the Technical Evaluation Guidelines and Checklist (for Digital Offline Resources) are generally satisfied by the VS5 based on the Evaluation of Interoperability.

**Support Browsers and Platform**

The Virtual Science 5 in Electronic Publication (EPUB) format was equally effective in different browsers such as Mozilla Firefox 2 & 3 and Microsoft Internet Explorer 6.0 in Microsoft Windows 2000, Mozilla Firefox for 2, Microsoft Internet Explorer 7.0 in Microsoft Windows XP, Apple Safari 2.0 on Apple OS X, and their updated versions. Moreover, the material is equally effective in operating systems/ platforms such as Windows (Vista, XP) and Mac (up to 10.5), likewise with Android systems and Apple IOS mobile phones. Linux, on the other hand, is an open-source operating system similar to Windows, Mac, and Android, although it is not largely commercially accessible in the locality.

**International Web Application Standards**

The Virtual Science 5 conformed to all international web application standards requirements. Particularly in the Markup language, which means that the VS5 has an XHTML

1.1 document type that is a fully functional document type with rich semantics. Conformance to style sheets also means that the material has several different units for expressing a length. Many of the CSS properties take "length" values, such as width, margin, padding, font size, etc. which are useful in making the overall interface aesthetically appealing and design consistent. Conformant to Portable Document Format (PDF) docs of Adobe and Rich Text Format (RTF) by Microsoft Word means that VS5 can contain links and buttons, form fields, audio, video, and business logic.

The PDF and RTF formats are useful since they are ubiquitous, which means they can be read by practically all word processors [27]. It was also determined that the VS5 conformed with the movie/video, and audio elements. This indicated the materials were able to play audio using the coding format for digital audio such as MP3. The evaluators have seen no conformity with MP2 since this is the standard for sound playback in digital television and radio and not for the Virtual Interactive material developed. VS5 likewise was conformant with movie/video formats such as AVI and SWF. These are the standard video formats for Windows machines and Adobe programs respectively. VS5 also contained hyperlinked FLV video files that are powered by Adobe Systems for online video on such websites as YouTube, can absorb the material content, their satisfaction with the mobility of their learning, and how the material's structure and other technical features help them become autonomous learners.

**Table 8. Student Feedback**

| Indicators | Median | Description |
|---|---|---|
| 1. The objectives of the lessons have been clear to me from the start of the lesson. | 4 | Strongly Agree |
| 2. The study guide was provided at the beginning of the lesson. | 4 | Strongly Agree |
| 3. The study guide was helpful in my study. | 4 | Strongly Agree |
| 4. The learning resources were appropriate and useful. | 4 | Strongly Agree |
| 5. The time given to finish the material is enough. | 4 | Strongly Agree |
| 6. The lesson was clear and easily understood. | 4 | Strongly Agree |
| 7. Activities and Performance Tasks were helpful for me to understand the lessons. | 4 | Strongly Agree |
| 8. The amount of time for evaluation is appropriate for the number of questions. | 4 | Strongly Agree |
| 9. I feel that this lesson will make me a good student. | 4 | Strongly Agree |
| 10. I am happy with the lessons in general. | 4 | Strongly Agree |

## 6. CONCLUSIONS

Drawing on the insights presented in the previous section, this research yields the following conclusions:

1. Non-print materials, encompassing cassette tapes, VHS tapes, DVDs, VCDs, CDs, slides (transparent photos), and transparencies, exhibit a low level of adequacy. This deficiency stems from their obsolescence, dilapidated condition, and impracticality when applied to distance learning.
2. Given that Grade 5 students' proficiency in science falls below the Close to Approximating Mastery or Mastery levels, coupled with an average performance, the endeavor to address Grade 5 Science competencies, contend with the low adequacy rate, and confront other challenges inherent in distance education necessitates the formulation of strategic academic solutions.
3. The utilization of a systematic approach, such as the ADDIE Model, emerges as indispensable for the development of effective instructional materials. Employing a sequential process, researchers successfully crafted "Virtual Science 5," an interactive learning resource designed to engage learners within a virtual classroom environment.
4. Notwithstanding criticisms from Branch and Merill [13] and Spatioti et al. [14] regarding the perceived linearity and rigidity of the ADDIE model, it remains a crucial tool in the realm of instructional design.
5. The "Virtual Science 5" material aligns with Validity Indicators, particularly meeting standards in Content Quality, Instructional Quality, and Technical Quality. Furthermore, it has undergone rigorous testing to identify and rectify any Technical Errors.
6. The usability evaluation of "Virtual Science 5" reveals it excels in Multimedia design, Overall interface, Behavior of Controls and System Information, Customizability/Support for User Preferences, Data Entry by User, and Hyperlinks.
7. In addition, "Virtual Science 5" satisfies interoperability standards, ensuring compatibility and seamless integration with diverse educational systems and environments.

## 7. RECOMMENDATION

Following exhaustive research, it is evident that Grade 5 students' proficiency in science has shown no discernible improvement in recent years. In response, it is highly advisable to leverage non-print resources, notably Virtual Science 5, to enhance the teaching and learning experience. To maximize the effectiveness of these resources, a systematic approach, such as the ADDIE model, should be employed throughout the development process. To ensure the success of these initiatives, continuous monitoring of student performance while utilizing these resources is imperative. Furthermore, a key imperative is the creation of additional non-print materials that align with stringent standards for Content, Instructional, and Technical Quality, alongside rigorous Technical Error assessments, before implementation. The development process should also incorporate a meticulous consideration of Usability Characteristics to guarantee user-friendly experiences, while comprehensive Interoperability evaluations should be conducted to ensure optimal accessibility and utilization. These strategic academic measures are poised to play a pivotal role in elevating Grade 5 science competency levels and providing robust support for the teaching and learning process.

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