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Research Article

Development and Validation of an Interactive E-Book in Physics 9

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ABSTRACT

The study developed and validated an interactive e-book in Physics in Grade 9 Science to help augment the learning gaps and the least mastered competencies based on the regional diagnostic assessment. The content of the lessons in the interactive e-book was based on the six (6) least learned, most essential learning competencies that were provided by the Department of Education. The material was conceptualized based on objectives, content or parts, and evaluation tools. The developed interactive e-book was validated in terms of content quality, instructional quality, technical quality, and other findings. Based on the results of the validation of the six (6) faculty experts, it revealed that the crafted material was very satisfactory in all the criteria, which means that it was valid and ready for use by the students. The learners evaluated the developed material in terms of content, adequacy of scope, and appropriateness of exercises. It inferred that the interactive e-book was acceptable and reliable for its intended users. The result of this study has a significant implication to teaching Physics to Grade 9 students. It means that the material can serve as supplementary material since the students were engaged in learning and had shown interest when the lesson involved educational technology, and since there are insufficient modern instructional materials in Physics.

Keywords: *Development and validation, Interactive e-book, Physics 9*

Introduction

Everything in life is a crossroad of choices. It is seen even in the selection of materials, and crafting of programs where teachers try to innovate for the learners. It is always a challenging task for teachers to augment the need of the learners and the skills, knowledge, and abilities that need to be developed with the presence of new ideas and effectiveness of actions created in the educational system where it aims for holistic growth and development to each learner in all aspects that may affect an individual in his daily living. Education is a human need that enables a person to widen what he knows, unfold

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skills in different perceptions, put on necessary knowledge to application, and the like. It has been an idea that is accurate and precise that education has always provided most people their need for knowledge, skills, and application. Generally, education is equipped with different subjects, which are the foundations that make an individual informed and skilled in various ways, especially with the help of the school, administrators, teachers, and resources such as modules, interactive e-books, online materials, and others.

The world has become part of the development of sustainability (SDG) in various community sectors, even before these sustainable development goals were defined and even when the global pandemic hit the world. Among these SDGs is its fourth goal, which is quality education. The goal highlights the essence of education in the development of the world. This goal is essential since it becomes the root of achieving other developmental goals and envisions guaranteeing quality education that supports equitable and inclusive quality education for all that promotes learners lifelong learning opportunities. With this view, Goal 4 infers that all children and learners worldwide will be able to attain lifelong learning and quality education by 2030. In addition, Goal 4 aims to develop and unfold the knowledge, skills, and abilities of learners, Yuan (2021).

In relation to the SDG, Roberto & Madrigal (2018) mentioned that PPST (Philippine Professional Standards for Teachers), known before as the National Competency-Based Teacher Standards (NCBTS) (D. O. No. 32, 2009), was developed to ensure the quality of teachers (D. O. No. 42, 2017). Teaching quality is known to be the most crucial factor in developing students' outcomes of learning. Hence, the factors affecting effective teaching should be identified and achieved to produce a single point of understanding on what the ways in the effective practice of teaching and learning are and determining the question on the effectiveness of PPST, as a response to the 21st century that aims to develop a common ground for a teacher who is employed in schools.

In the Philippines, Science education may be seen in different aspects. There are various factors that may be attributed to the country's present predicament. Some examples of these factors include the lack of science educators in the schools, scarcity of the facilities, science laboratories that include all the materials needed in the learning process, the poor quality of learners' instructional modules, and others such as teachers reporting books which have errors (technical and content) and are also outdated. The problems in Philippine education impact how public schools can teach and instruct learners in the subject. These restrictions create a perception of how Science education is developed in the country, Sadera, Torres & Rogayan, (2020).

Meanwhile, the 2019 edition of the Trends in International Mathematics and Science Study (TIMSS) provided the government the scores of 297 in Mathematics and 249 in Science. This result mean that the country is among the 58 countries included in the study that scored low. It means that only 13 percent of Filipino students who were considered knowledgeable in the subject. It also implies that Filipino learners demonstrate minimal understanding of scientific concepts and facts. This finding infers that the Philippines should use these international assessments to create actions and solutions that will impact the student's learning and development towards improving science education.

In addition to this finding, there was a Regional Memorandum in Region III no. 54, s. 2022 or the Conduct of the 2022 Regional Diagnostic Assessment in All Learning Areas from Grades 1-10 and Core Learning Areas in Grades 11-12. The assessment was crafted to assess students' learning where the assessment tool used are teacher-made tests that will determine their previous grade level. As the locale of the study is a participant of the RDA, there were only 13% or 29 out of 230 learners in Grade 9 Science. The results mean the percentage of learners who achieved or exceeded the MPL is meager. The results reveal that most of the students do not master the learning competencies in their previous year in Science 9. In the area of physics, there were six least learned competencies in the locale of the study where the interventions like interactive e-books to be crafted should be based on these results. This encounter with the challenge should be

addressed to improve students' learning and teachers' ease of instruction. The learners' gaps in understanding Physics were affected during the two years of distance education since laboratory practices, experimentations, and other scientific applications in the subject were not feasible for two years, and the students adjusted to the pre-requisite of the school subject.

As mentioned by Bernardo, et al. (2018), the perceptions of the students should be considered in the system of education. The implementers should envision progress in the design of Philippine science curriculum. In addition, there are mistakes and flaws that the learners themselves see in the education process they are in. With the students' difficulties in learning Physics, it becomes a complex subject as it has different information and skills to acquire. There should be more instructional materials that are effective in the instruction.

In addition, Orleans (2007) stated that restricted materials for instruction and educational technologies, the lack of teacher training programs, unfavourable resources in the library, and the lack of internet access have affected the way Physics is viewed by the students. It also shows that teachers have high involvement in imparting the lessons to the students. With these challenges, administrations are tasked to develop competent teachers wherein schools should be equipped with materials and technologies to be used by the teachers and learners.

One way in mitigating this problem is to provide an intervention to ensure that gaps will be bridged systematically (DepEd Order No. 39 s. 2012). One of the suggestions is to offer and craft supplementary materials that are important and are desired to unfold the competencies of those schools with limited instructional time due to the unavailability of classrooms. With the intended ideas in enhancing the secondary learners the envisioned knowledge they have to acquire through the provided intervention and supplementary materials such as interactive e-books, teachers have become sure in the instruction that students will be accepting the desired competencies that they need to learn. Enhancement programs are essential in developing the needs of the students in coping with the gap in understanding the subject.

There is a need for teachers and learners to augment the gap in the educational process. One of the interventions that can enhance students' knowledge and learning in the subject would be supplemental materials such as modules, interactive books, and ICT materials. Modules, interactive e-books, and other educational technologies are examples of supplemental and intervention materials that are likely preferred by teachers and learners in distance learning. This result was found in the survey of the Department of Education in 2020. The use of modules, interactive e-books, and other supplementary resources may be utilized in teaching Science in public schools. These materials are likely to enhance the knowledge and skills of the learners in various lessons since they are created according to their needs.

One material is interactive e-books which have been found to have a significant impact on developing scientific concepts to students and will help them in these modern technological innovations (Shemmy, 2020); Albertp (2019). The content, instructional, and technical quality must be appropriately identified to create the best materials, which can be printed materials or interactive e-books, which are generally used in this digital age and new average age for the learners. These should be appropriately designed in the content, instructional, and technical quality for the primary users, who are the students, to quickly grasp the lessons and topics with the most essential competencies.

Thus, along with all the underlying principles, this study was designed to craft and validate an interactive e-book focusing on the (6) least learned competencies in Physics 9, which seeks to determine the significant difference between the pre-test and post-test scores of the learners through the crafted instructional material. In addition, this research was developed to augment the learners' difficulties in Physics 9 that will be carried out to their next grade level in a spiral curriculum. Hence, the designed interactive e-book was subjected to determining its implication for teaching Physics in Junior High School.

Statement of the Problem:

1. How can the interactive e-book in Physics be developed and described in the areas of:
   1.1 Objectives;
   1.2 Content/Parts; and
   1.3 Evaluation Tools.
2. How can the developed interactive e-book in Physics be validated by the experts along areas of:
   2.1 Content Quality;
   2.2 Instructional Quality;
   2.3 Technical Quality; and
   2.4 Other Findings
3. How may the acceptability of the developed interactive e-book be evaluated by the students?
4. How may the effectiveness of the interactive e-book be described in terms of the pre-test and post-test results?
5. What are the implications of the study's findings on science education?

Methods

Research Design

The study utilized the educational research method known as Research and Development (R&D) in developing and validating the crafted interactive e-book in Science 9 focusing on Physics. It is a method to develop and validate educational products (Alberto, 2019). The current study is developmental since the researcher crafted an interactive e-book that was used to augment the difficulties of the students, and the essential learning competencies in Physics.

The study also employed Pre-Experimental Research Design using the developed interactive e-book. The study was pre-experimental as it gathered one group of participants that underwent a pre-test before the use of the developed material and conducted a post-test after the instruction using the crafted learning material.

Research Respondents

The participants in the study were chosen through a cluster sampling of the six heterogeneous sections of grade 9 of Rodolfo V. Feliciano Memorial High School, Magalang, Pampanga, for the school year 2022-2023. Among the six sections, one team, with 54 students, was chosen using the fish bowl technique as the participants for the entire study who underwent pre-test, instruction using the interactive e-book, and post-test. They also evaluated the interactive e-book using the tool adapted from the study of Valerio (2008) as to the content, adequacy of scope, and appropriateness of exercises.

Meanwhile, there were six (6) faculty experts – one (1) Head Teacher in Science, (2) Master Teachers in Science, (1) LRMDS Expert, one (1) Grade 9 Science Teacher, one (1) ICT Coordinator who served as the validators in evaluating the crafted and developed interactive e-book based on LRMDS Rating Tool for Non-Print Materials as to the content, instructional, technical quality, and other findings.

Data Analysis

Data Gathering Procedure

To gather all the needed data to answer the questions posed in the study, the following tools and procedures were utilized:

The researcher adapted the ADDIE model in designing the interactive e-book in Science 9, which followed the five steps: analysis, design, development, implementation, and evaluation. An interactive e-book was crafted based on the six (6) least learned competencies in the Physics area in Science Grade 9 during the conduct of the Regional Diagnostic Exam at the beginning of the school year on August 2022 in the locale of the study. The interactive e-book was conceptualized based on the objectives of the instructional material to, why and how it was carried out, content or topics to be covered in the material, and assessment tools that were used in the interactive e-book.

After the interactive e-book was created, it underwent validation. In this stage, the material was validated by faculty experts whose expertise is relevant to Science education and assessment. The interactive e-book was evaluated according to the DepEd LRMDS Rating Sheet for Non-Print Materials regarding content quality, instructional quality, technical quality, and other findings. Moreover, the end-users or the learners evaluated the material using the adopted tool of Valerio (2008) in terms of content, adequacy of scope and appropriateness of exercises.

Before the conduct of the pre-test on the participants of the study, a pilot testing of the pre-test was done in another section of the Grade 9 to identify the discrimination index and difficulty index of the items. The participants' learning was determined based on the pre-test, where the items are relevant to the learning competencies, and lessons or topics in Physics in Grade 9. The pre-test diagnosed and assessed the least learned competencies of the participants before the conduct of the teaching using the developed material.

After the conduct of the pre-test, the teaching was provided using the interactive e-book in Physics 9. Pilot testing was applied to distinguish the issues, problems, and effects of the developed interactive e-book to participants before it was used in different sections after the study. This procedure helped in the determination of the feasibility and practicality of the methods to be employed

Post-test

The post-test was used after the interactive e-book was applied in the teaching of Physics in Grade 9. The post-test evaluated the learning competencies which were mastered by the participants after the conduct of the instruction where the interactive e-book was employed.

Statistical Treatment of the Data

The study was developmental and pre-experimental, whereas it utilized statistical treatments and the following tools to gather and interpret data. The data were tabulated and tallied to get the mean scores, frequency, percentage, and standard deviation of the development and validation of the interactive e-book in Physics 9. In contrast, the significant difference between the pre-test and post-test scores of the participants was identified through Paired t-test.

Result and Discussion

A. Development of the Interactive E-Book

The researcher wanted to develop a supplementary learning material for the students in learning Physics that will be appealing and interesting to them. The material was conceptualized by having the objectives, content and evaluation tools that followed the existing format for Self-Learning Modules of the DepEd. The objectives of the developed material were the six (6) least mastered out of eight (8) most essential learning competencies provided in the fourth quarter of Grade 9 Science. The content and evaluation tools of the material were based on the learning competencies and lessons provided in the modules. The material was crafted with the following steps: first, the content of the modules was created using the word file, second, Canva was used for overall design of the modules such as the used of elements that are relevant to the topics. Lastly, the designed output from Canva was saved as picture file or portable network graphics and .Mp4 file to Slidedeck that made it into the video lessons.

B. Experts' Validation on the Developed Interactive E-Book

Table 1. Content Quality

	Statement	Mean Rating	Description
1.	Content is consistent with topics/skills found in the DepEd learning competencies for the subject and grade/year level it was intended.	4.00	Very Satisfactory
2.	Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	4.00	Very Satisfactory
3.	Content is accurate.	4.00	Very Satisfactory
4.	Content is up-to-date.	4.00	Very Satisfactory
5.	Content is logically developed and organized.	4.00	Very Satisfactory
6.	Content is free from cultural, gender, racial, or ethnic bias.	4.00	Very Satisfactory
7.	Content stimulates and promotes critical thinking.	4.00	Very Satisfactory
8.	Content is relevant to real-life situations.	4.00	Very Satisfactory

Statement	Mean Rating	Description
9. Language (including vocabulary) is appropriate to the target user level.	4.00	Very Satisfactory
10. Content promotes positive values that support formative growth.	3.83	Very Satisfactory
Total	**3.98**	**Very Satisfactory**

Table 1 shows the validation of the interactive e-book as to content quality. It is seen that most of the statements got a mean rating of 4.00, which is described as very satisfactory. Meanwhile, the criterion that the material's content promotes positive values got a mean of 3.83. This means that the content of the interactive e-book is sufficient for the learning needs of the students as it gathered a total mean of 3.98.

Table 2. Instructional Quality

Statement	Mean Rating	Description
1. Purpose of the material is well defined.	4.00	Very Satisfactory
2. Material achieves its defined purpose.	4.00	Very Satisfactory
3. Learning objectives are clearly stated and measurable.	4.00	Very Satisfactory
4. Level of difficulty is appropriate for the intended target users	4.00	Very Satisfactory
5. Graphics / colors / sounds are used for appropriate instructional reasons.	4.00	Very Satisfactory
6. Material is enjoyable, stimulating, challenging, and engaging.	3.83	Very Satisfactory
7. Material effectively stimulates creativity of target user.	4.00	Very Satisfactory
8. Feedback on target user's responses is effectively employed.	3.83	Very Satisfactory
9. Target user can control the rate and sequence of presentation and review.	4.00	Very Satisfactory
10. Instruction is integrated with target user's previous experience.	4.00	Very Satisfactory
Total	**3.97**	**Very Satisfactory**

Table 2 presents the validation of the interactive e-book as to instructional quality. It is evident that most of the statements got a mean score of 4.00, which is described as very satisfactory. However, the criteria that the material is enjoyable, stimulating, challenging and engaging and the feedback is effectively employed both got a mean of 3.83 which is inferred that the material was not yet utilized to the leaners during the validation.

Table 3. Technical Quality

Statement	Mean Rating	Description
1. Audio enhances understanding of the concept.	4.00	Very Satisfactory
2. Speech and narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood.	4.00	Very Satisfactory
3. There is complete synchronization of audio with the visuals, if any.	3.83	Very Satisfactory

Statement	Mean Rating	Description
4. Music and sound effects are appropriate and effective for instructional purposes.	3.83	Very Satisfactory
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	4.00	Very Satisfactory
6. Visual presentations (non-text) are clear and easy to interpret.	4.00	Very Satisfactory
7. Visuals sustain interest and do not distract user's attention.	4.00	Very Satisfactory
8. Visuals provide accurate representation of the concept discussed.	4.00	Very Satisfactory
9. The user support materials (if any) are effective.	3.83	Very Satisfactory
10. The design allows the target user to navigate freely through the material.	4.00	Very Satisfactory
11. The material can easily and independently be used.	4.00	Very Satisfactory
12. The material will run using minimum system requirements.	3.83	Very Satisfactory
13. The program is free from technical problems.	3.83	Very Satisfactory
Total	**3.94**	**Very Satisfactory**

Table 3 shows the validation of the interactive e-book as to technical quality. It is inferred that the items under audio, visuals, display and design got a mean of 4.00, described as very satisfactory, while items such as synchronization, effectiveness, users' support and being free form technical problems got a mean of 3.83, also described as very satisfactory.

Table 4. Other Findings

Statement	Mean Rating	Description
1. Conceptual Errors	4.00	Very Satisfactory
2. Factual Errors	4.00	Very Satisfactory
3. Grammatical and / or typographical errors.	4.00	Very Satisfactory
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.).	4.00	Very Satisfactory
Total	**4.00**	**Very Satisfactory**

Table 4 presents the validation of the interactive e-book as to other findings. As shown, all the statements had a mean rating of 4.00, described as very satisfactory. This means that there were no errors presented in the interactive e-book that makes it invalid to its end-users. This infers that the material is ready to be used to its target users since errors were not present.

Table 5. Students' Evaluation on the Developed Interactive E-Book

Statement	Mean Rating	Description
Content	4.99	Strongly Agree
Adequacy of Scope	4.97	Strongly Agree
Appropriateness of Exercises	4.96	Strongly Agree

Table 5 presents the students' evaluation of the interactive e-book as to content, adequacy of scope and appropriateness of exercises. As shown, the students strongly agreed that the lessons in the interactive e-book were explicitly explained and it provided

relevant learning exercises to them since it got a total mean score of 4.99, which is described as strongly agree. Meanwhile, the evaluation of the developed e-book as to adequacy of scope got a total mean of 4.97, where the students strongly agreed that the information and scope is sufficient in learning the lessons and the competencies required.

Table 6. Paired Samples T-test of the Pre-Test and Post-Test Results

	statistic	df	p	Mean difference	SE difference		Effect Size
Student's t	14.7	53	< .001	17	1.16	Cohen's d	2

Note. $H_a\ \mu_{\text{Measure 1 - Measure 2}} \neq 0$

Table 6 presents the correlation of the pre-test and post-test results of the students with the use of the interactive e-book. As shown, the p-value of the results is less than .001 which means that there is a significant difference between the results of the test. Accordingly, a p-value less than .005 indicates a significant difference between pre and post-test. Also, it is seen that the post-test scores of the students is (2) standard deviation greater than pre-test scores. This infers that the use of developed material as applied in teaching Physics to students is excellent.

Conclusion

Based from the findings of the study, these conclusions were drawn:

1. The crafting of the interactive e-book in Physics 9 was based on objectives, content or parts, and evaluation tools.
2. The developed material was validated by faculty experts using the Department of Education's LRMDS Tool in Evaluating Non-Print Materials in terms of content, instructional, technical quality and other findings and found to be very satisfactory in all the criteria.
3. The developed and crafted interactive e-book was also evaluated by its end-users with its acceptability in terms of content, adequacy of scope and appropriateness of exercises and found to be acceptable and valid.
4. The interactive e-book was effective as the post-test scores are greater than the pre-test scores.
5. Educational technologies such as interactive e-books are effective in catching students' attention and interest in learning the subject.

Based from conclusions of the study, the following were recommended:

1. Teachers should utilize interactive e-books in teaching to make learning the lesson interesting, enjoyable and exciting.
2. The crafted interactive e-book may be adopted and utilized as a supplementary material by Grade 9 Science teachers in teaching the learning competencies in Physics.
3. Further studies on the utilization of interactive e-books may be employed in other areas of Science teaching in different levels of instruction to identify the effectives of educational technologies in various areas.

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