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Development and validation of multimedia-based instructional module in Science 7

Christian R. Basilio[1], Eivan Mark S. Sigua[2]
[1]*Tinajero National High School Annex-Department of Education, Philippines*
[2]*College of Education-Pampanga State Agricultural University, Philippines*
Corresponding Email: christian.basilio001@deped.gov.ph

ABSTRACT

This study aimed to develop and validate a multimedia-based instructional module in Science 7. This was initiated as a response to the poor performance of Filipino learners on international and national standard assessments in Science. A descriptive approach of research was utilized in developing and validating the module. Each lesson in the module consisted of the following parts: learning objectives, pretest, discussion of the topic, activities, posttest, and references. The development of the module underwent four phases: planning, content validation and analysis, designing, and development. The Lawshe's content validity formula was used in determining the essential learning competencies that were included in the module. A validation tool was used by ten experts in validating the content, design/format, technical/technological, and pedagogical aspect of the module. Results of the study showed that all of the validators agreed that the developed multimedia-based instructional module in Science 7 met all the criteria found in each parameter on the validation tool. Therefore, it was concluded that the developed multimedia-based instructional module can be used as instructional material by Science 7 learners.

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INTRODUCTION

To strengthen the system of basic education in the Philippines, Republic Act 10533 or the Enhanced Basic Education Act of 2013 was signed into law. This law paved the way for the development and implementation of the K-12 program. The program aims to produce citizens who are empowered with the essential abilities and values needed for life-long learning, employment, and the challenges of the 21st Century (Official Gazette, 2013; Department of Education (DepEd, 2019).

Science is one of the major subjects under the K-12 program. The main goal of science education is to produce scientifically literate learners who can use and apply scientific knowledge prudently (Dela Fuente, 2019; Ferido, 2013). It also aims to provide the learners with the competencies needed in a knowledge-based society, and employment. At the end of the entire Science curriculum, the learners are expected to show knowledge of basic science concepts, apply science-inquiry skills, and display scientific attitudes and values (DepEd, 2016). By the realization of the K-12 program, the science curriculum has undergone educational reforms and innovations. Concepts and skills in these areas are taught in a spiral progression (Cabansag, 2014). The level of complexity of each science concept increases as the learners move from one grade level to another. This design provides the learner with a deeper understanding and mastery of core concepts after each level. Moreover, the science curriculum shifts from traditional methods in instruction to learner-centered and inquiry-based methods of teachings, which aims to enhance the critical thinking and scientific skills of students (Montebon, 2014).

However, despite of these innovations and educational reforms in the Science curriculum, its goals seem arduous to be achieved. This can be reflected by the poor results of international and national standard assessments conducted on Filipino learners. The National Achievement Test (NAT) administered to elementary and secondary learners in 2015 resulted in a mean percentage score of 57.11% in the secondary and 68.32% in the elementary (Logmao, 2019). Likewise, the Department of Science and Technology (DOST) reported that only 9,788 (9.55%) out of 102,526 graduating high school learners who took the DOST scholarship secured a slot in the country's premier Science scholarship program for the Academic Year 2020-2021 (DOST, 2020). The 2018 Programme for International Student Assessment (PISA) revealed that the Philippines ranked second last in both mathematics and Science among 79 participating countries (Organisation for Economic Cooperation and Development, 2019).

This poor performance of students has stimulated researchers to identify the different factors attributed to the low academic achievement of students. In the context of Science education, individuals foresee science as a difficult subject, and this difficulty is because science subjects are dense, full of memorization, and mathematical (Syahroni et al., 2016). The results of TIMSS 2011 revealed that students who studied in schools with inadequate materials and resources such as library materials and multimedia resources had lower achievement in science than those students who studied in well-equipped schools (Martin et al., 2012). Deployed science teachers who are non-major professionals, lack of advanced laboratory materials and equipment, insufficient resources of teaching tools, and techniques and strategies in teaching science are the factors that contribute to increasing least-learned areas in science, which negatively affect the National Achievement Test in the Philippines (Linog et al., 2013). With this, Section 10.3 of Republic Act 10533 mandates the production and development of teaching and learning materials that are produced locally (Official Gazette, 2013). The Department of Education also states that there should be sufficient production of pertinent and contextualized instructional materials to supplement the use of textbooks (Agamata, 2018). Furthermore, DepEd Order no. 35, s. 2016 encourages teachers to enrich the teaching and learning process by integrating strategies utilizing Information and Communication Technology (ICT) that are appropriate for the development of students (DepEd, 2016).

Instructional module and its role in academic achievement

One of the solutions employed by DepEd to meet the standards of the K-12 Curriculum is the development of self-learning modules. A module is a learning material that contains systematic learning activities developed to aid a student to achieve a set of objectives (Goldschmid & Goldschmid, 1973). It supports independent study, and

students are learning how to learn. It promotes the acquisition of better self-study or learning skills among students. Activities in a module are structured from easy to difficult to gain mastery of the concepts (Nardo & Hufana, 2014). The use of a module in instruction is based on the principle of learning by doing, wherein the learner study by himself and verifies the correctness of his work by comparing it with the correct one, thus, providing immediate feedback (Guido, 2014). It enables the learner to pace at his own rate of speed so that learning progress is known to both student and instructor at all times and is based on measured understanding (Kaur et al., 2017 Similarly, a self-paced learning module is designed with a set of instructions that are logically crafted to facilitate the learner's mastery of a body of knowledge. Furthermore, self-learning modules are designed with learning activities for students who are not able to attend individual or group educational sessions (Vijayaragavan et al., 2018).

Role of technology in learning

Technology has moved almost every aspect of life, and education is not an exception. The integration of ICT in teaching and learning involves the process of utilizing technology to promote learning to the students. It allows teachers and students to enhance their abilities and skills in manipulating technological tools (DepEd, 2016). An education supported by technology allows the learners to be at the center and manifest a better grasp of the concepts than an education designed using traditional approaches (Schreyer-Bennethum & Albright, 2011). In the context of science education, one of the identified solutions to support learners in enhancing their scholastic achievement is the integration of technology (Costley, 2014). Likewise, research suggests that the inclusion of modern instrumentation positively affects the perception of students in learning scientific ideas (Aurentz et al., 2011). Furthermore, teaching science with technology allows learners to experience authentic learning by replicating real-world problems (Ucar, 2015). In sum, ICT devices and ICT-based activities promote greater learning in science class; they made the students engage in the process, and it also provides a new avenue of knowledge accessibility (Maharaj-Sharma & Sharma, 2017). Similarly, when lessons are presented using ICT, students show a higher level of enthusiasm in learning (Donnelly et al., 2011).

Multimedia and its role in learning

Multimedia is defined as the use of an electronic device such as a computer in presenting and combining graphics, video, text, and audio. It uses links and tools which enable the user to move along the material, create, collaborate, and communicate ("Defining Multimedia", n.d.). In the context of education, learning through multimedia is attributed to the students' development of information from words (spoken or printed form) and pictures (illustrations, diagrams, maps, photos, animations, and videos). It represents a potentially powerful technology designed to enhance human learning (Mayer, 2017). The dynamic and interactive settings of multimedia education are proven to be more effective than traditional printed materials. This feature is more expressive in presenting abstract concepts and can promote creative thinking and engagement to the students (Cheng et al., 2010). The elements of multimedia, which include text, graphics, audio, video, and animation, aid the teaching and learning process by making it interactive. It also encourages deep reflective thinking (Akinoso, 2018). Various researches support the assertion that multimedia instruction can promote learning. Sadaghiani (2012) revealed in his study that those students who used multimedia learning modules in mechanics achieved higher scores than those students who used textbooks. Leow and Neo (2014) developed an interactive learning module to form a multimedia-mediated student-centered learning environment. Their study revealed that this type of learning environment improved students' learning achievement. The students' attitude towards learning was positively affected; they became self-directed learners and developed a proactive attitude in the learning process. Similarly, Kareem (2018) posited in her study that lessons presented using multimedia aided instruction is more effective and better comprehended by students. It helps the students in developing a positive attitude towards learning Biology. Likewise, Shah and Khan (2015) concluded in their study that multimedia-aided teaching improves students' attitude towards science and helps in developing higher-order cognitive skills.

Based on the literature cited, it is evident that there is a problem in the academic achievement of Science learners in the Philippines. It is also found out that the utilization of modules has a positive impact on the academic

performance of the students by supporting and supplementing the learning process. Furthermore, it was also concurred by the researchers that applying technology and multimedia in the educative process enhances the students' scholastic achievement. Hence, it is for these reasons why the researchers prodded to develop a multimedia-based instructional module in Science 7, which aimed to improve the academic performance of students in Science 7.

Objectives

This study generally intended to develop and validate a multimedia-based instructional module in Science 7. Specifically, it intended to fulfill the following questions:

1) How may the multimedia-based instructional module in Science 7 be developed?
2) How may the multimedia-based instructional module in Science 7 be validated in terms of:
    2.1) content
    2.2) design/format
    2.3) technical/technological aspect
    2.4) pedagogy

METHODS

This study utilized quantitative research methods using descriptive approaches of research in developing and validating the multimedia-based instructional module in Science 7. Descriptive studies can provide valuable data that contributes to the production of essential recommendations; it is a purposive method that describes and organizes the data collection (Creswell & Plano, 2011). Developmental research involves the methodical study of *"designing, developing, and evaluating educational programs, processes,"* and products that must conform to a set of internal consistency and effectiveness (Richey, 1994). It is the most important research methodology utilized to create instructional materials (Ibrahim, 2016).

Evaluators

This study consisted of three sets of evaluators. The topics to be included in the multimedia-based instructional module were determined by ten experts who have experience in teaching Science 7 for three years, and above. The content and pedagogical aspect of the multimedia-based instructional module was validated by five Science experts- three master teachers, one head teacher, and one teacher who is handling Science 7 for more than three years. Meanwhile, the design/format and technical/technological aspect of the multimedia-based instructional module was validated by five LRMDS and ICT experts- one ICT coordinator, one LRMDS coordinator and book author, and three ICT experts who have experience in training, using, and developing digital tools for teachers. Purposive sampling of research was used in determining the three sets of evaluators.

Instruments

The *"Evaluation Instrument for Topics to be Included in the Distance Education and Open Distance e-Learning Module"* developed by the experts of College of Education of Pampanga State Agricultural University (CoEd-PSAU) was utilized to figure out the content validity of the topics included in the multimedia-based instructional module in Science 7. The Science experts decided if the topics to be included in the multimedia-based instructional module in Science 7 were essential or not essential. On the other hand, the developed multimedia-based instructional module in Science 7 was validated using the "*Evaluation Rating Sheet for Distance Education and Open Distance e-Learning Modules"* developed by the experts of CoEd-PSAU. It was a Yes or No questionnaire wherein the science experts, and LRMDS and ICT experts decided if the multimedia-based instructional module in Science 7 met the set criteria on the evaluation tool. The multimedia-based instructional

module in Science 7 was validated based on the four factors found in the evaluation rating sheet: content, design/format, technical/technological, and pedagogy.

Procedure

This study underwent three phases: planning, development, and validation.

Planning Phase

In the planning phase, a letter was sent to the school principal to seek approval for the conduct of the study. The planning phase also included the identification of the essential learning competencies in Science 7. These essential learning competencies in Science 7 were determined by the selected science experts using the "*Evaluation Instrument for Topics to be Included in the Distance Education and Open Distance e-Learning Module"*. An online form that contained the digital format of the evaluation instrument was sent to the email address of the selected evaluators. This was where the evaluators marked their responses.

Development Phase

The development phase was the actual making of the multimedia-based instructional module in Science 7. It was developed using an e-book creator and editor. It consisted of the following parts: (A) Learning Objectives / What I Need to Know?; (B) Pretest / What I Know?; (C) Discussion of the topic / What is it?; (D) Activities / What I have learned; (E) Posttest / Assessment; and (F) References. The design of the multimedia-based instructional module consisted of interactive features through hyperlinks, pictures, audios, and educational videos to make it engaging and appealing to the students. Tabs with specific functions were included for easy access and navigation in the module. These tabs include chapters tab, notebook tab, settings tab, search tab, navigations tab, add note tab, and submit answers tab.To access the module, the learner needs to download the electronic publication (EPUB) file version of the module. Also, an electronic EPUB file reader is needed to be downloaded to use the module. This module can be accessed on any digital device as long as it can run an EPUB file reader.

Validation Phase

In the validation phase, the Science experts and LRMDS/ICT experts rated the multimedia-based instructional module according to the set criteria found on the Evaluation Rating Sheet for Distance Education and Open Distance e-Learning Modules developed by the experts of (CoEd-PSAU). The module was sent to the e-mail address of the evaluators. Also, an online form that contained the digital format of the evaluation instrument was sent to the email address of the selected evaluators. This was where the evaluators marked their responses. Revisions were made based on the suggestions and recommendations of the experts. The collected data were subjected to statistical tests with the help of a statistician. The content validity ratio formula constructed by Lawshe (1975) was utilized to determine the content validity of the learning competencies included in the multimedia-based instructional module. The formula is CVR = [(E - (N / 2)) / (N / 2)], wherein CVR is content validity ratio, E is the number who rated the object as essential, and N is the total number of experts. A minimum CVR value of 0.62 for ten experts is needed in order for a learning competency to be considered as essential, and be included in the module. Otherwise, a learning competency that will receive a CVR value of less than 0.62 will be considered as not essential, and will not be included in the module. Frequency and percentage were employed in analyzing the validation ratings of experts on the multimedia-based instructional module.

RESULTS AND DISCUSSION

Table 1. Stages of development of the multimedia-based instructional module

Stages	Activities
Planning	Preparation of reference materials.

	Preparation of the list of learning competencies in Science 7. Identification of the validators of the learning competencies in Science 7, and validators of the developed module
Content Validation and Analysis	Validation of the learning competencies in Science 7. Identification of the essential and nonessential learning competencies using Lawshe's content validity ratio formula. Identification of the essential learning competencies that will be included in the module.
Designing	Grouping of the essential learning competencies according to their domains in Science Identification of the software to be used in making the module. Determining the parts of each lesson in the module. Writing the content of each lesson in the module. Lay-outing the design and features of the module.
Development	Creating the multimedia-based instructional module using an e-book creator and editor. Creating the user manual of the module.

Table 1 presents the different stages of development that the module underwent. The development of the module consists of four stages: planning, content validation and analysis of the learning competencies, designing of the module, and development of the module. The content validation and analysis of the learning competencies revealed that out of 45 learning competencies, 32 learning competencies received CVR values greater than the minimum value of CVR of ten experts which is 0.62. This means that these learning competencies were essential and were included in the module. These identified essential competencies acted as the reference of the researchers in developing the content of the module. On the other hand, 13 learning competencies received a CVR value that is less than to the minimum value. These learning competencies were considered not essential, and not included in the module. The 32 learning competencies were grouped according to their domains in Science. Four domains were determined and served as the basis in dividing the module into four chapters.

Table 2. Evaluation of experts on the content of the multimedia-based instructional module

Factor 1: Content	YES		NO	
	f	%	f	%
"The topics/lessons included in the module are very relevant to the main goal of the course and greatly contribute to the achievement of the specific lesson objectives."	5	100.00	0	0.00
"The module provides information that are very important and useful to the students who will be utilizing it."	5	100.00	0	0.00
"Adequate information is being provided in every lesson with links and references included to guide students for further research activities."	5	100.00	0	0.00
"The content is presented clearly using language that is understandable and suited to the level of the target learners."	5	100.00	0	0.00
"The knowledge and ideas being presented in every unit are accurate, recent and free from errors using terminologies that suit the distinct characteristics of the target learners."	5	100.00	0	0.00

Table 2.1 delineates the evaluation of experts on the content of the multimedia-based instructional module in Science 7. Five or 100 % of the evaluators agreed that the module met all the criteria included in the first factor. This means that the lessons included in the module were in line with the learning competencies developed for Science 7. The content of each lesson provides an opportunity for students to attain the specific objectives of each lesson. The finding of the study also signifies that the information found in the multimedia-based instructional module was adequate, important, relevant, and useful to Science 7 learners who will use it. It also contains additional references that the students may use for further learning to understand the concepts found in each lesson. Moreover, the result of the study also indicates that the content of the multimedia-based instructional module is

presented using language and terminologies that is easy to understand and suited to Science 7 learners. This result conforms with Goldschmid & Goldschmid (1973), who stated that a module contains planned activities designed to help students to achieve a set of objectives.

Table 2. Evaluation of experts on the design/format of the multimedia-based instructional module

Factor 2: Design/Format	YES		NO	
	f	%	f	%
"Textual information is presented clearly with appropriate choice of font size and style including other formatting features that could enhance the appearance of the texts (e.g. italics, boldface, underline, etc.)."	5	100.00	0	0.00
"Proper spacing is observed in between texts, sentences, and paragraphs including margin and indention to avoid congested page."	5	100.00	0	0.00
"The graphics used and other media elements utilized (audio, video, animation etc.) are motivating and very relevant to the topics presented."	5	100.00	0	0.00
"Main topics, subtopics, specific discussions and other important parts of the module are properly labelled for easy recognition."	5	100.00	0	0.00
"The module is properly organized and packaged in such a way that all the parts compliment with one another and each part contains clear directions for students to follow."	5	100.00	0	0.00

Table 2.2 presents the evaluation of experts on the design/format of the multimedia-based instructional module in Science 7. Five or 100 % of the evaluators agreed that the module met all the criteria included in the second factor. This means that the textual information found in the multimedia-based instructional module was presented using font sizes and styles appropriate to Science 7 learners. The spacing of text between sentences and paragraphs was properly observed which makes the pages in each module easy to read. The results also demonstrated that the media elements such as graphics, audio, and video clips used in the multimedia-based instructional module were motivating and relevant to the topics presented. Akinoso (2018) affirmed that the elements of multimedia, which include text, graphics, audio, video, and animation, aid the teaching and learning process by making it interactive. It also encourages deep reflective thinking. Furthermore, the results also point out that the sections of the module were easily recognized since they were marked properly. The module was also systematically crafted in a manner that all sections of the module complement one another. Likewise, each segment of the module consists of easy-to-follow instructions for learners.

Table 3. Evaluation of experts on the technical/technological aspect of the multimedia-based instructional module

Factor 3: Technical/Technological	YES		NO	
	f	%	f	%
"Use of the module does not require equipment or applications beyond what is typically available to the students (e.g. operating systems, browsers, application softwares)."	5	100.00	0	0.00
"The module can be accessed by students either through the internet (online) or offline by providing them both hard and electronic copy (from CD, flash drive and other modes of transferring files)."	5	100.00	0	0.00
"The module can be embedded or fully integrated into a Learning Management System for wide dissemination and accessibility."	5	100.00	0	0.00
"The module has a user-friendly interface and navigational tools that even novice users can easily follow."	5	100.00	0	0.00
"The module provides students opportunity to interact with the teacher and other students through various communication tools provided such as email, messenger, videoconferencing etc."	5	100.00	0	0.00

Table 2.3 presents the evaluation of experts on the technical/technological aspect of the multimedia-based instructional module in Science 7. Five or 100 % of the evaluators agreed that the module met all the criteria included in the third factor. The results mean that the multimedia-based instructional module could be used using an application that is easily downloaded by the students. It also had learner-friendly features that even beginners can understand. The module could also be accessed by students online by downloading it on a Learning Management System set by the teacher. For those students who do not have an internet connection, they can access it offline by providing them with an electronic copy saved in a flash drive or by transferring it via Bluetooth. Furthermore, the results also indicate that the module provided students with favorable circumstances to reach out to their teacher by providing different platforms of communication. These findings adhere to the principles of access of 21st-century quality education which requires learning resources to be accessible to a range of technology available to users. It can be used and shared using various platforms, software, and hardware (DepEd, 2009).

Table 4. Evaluation of experts on the pedagogy of the multimedia-based instructional module

Factor 4: Pedagogical	YES		NO	
	f	%	f	%
"Objectives are well-formulated giving clear direction and establish a sense of expectancy among students."	5	100.00	0	0.00
"Prior knowledge of students is properly assessed to bridge the gap between what they already know and what they have to know."	5	100.00	0	0.00

"Various motivational and cognitive strategies are properly embedded in every lesson/unit to keep students on track. "	5	100.00	0	0.00
"Tasks or activities required in the module are very relevant to the main objectives of the course and lessons and must be realistic considering the resources available (e.g. time, materials, equipment, etc.)."	5	100.00	0	0.00
"The module provides provision for individual differences by supporting diverse learners with different learning styles, preferences, interests and experiences."	5	100.00	0	0.00
"Assessment tools included ensure the development of higher-order thinking skills such as critical and creative thinking."	5	100.00	0	0.00
"The module also provides good feedback mechanism so learners can regularly receive formative feedback on learning (i.e. they can track their performance, monitor their improvement, test their knowledge)."	5	100.00	0	0.00

Table 2.4 presents the evaluation of experts on the pedagogy of the multimedia-based instructional module in Science 7. Five or 100 % of the evaluators agreed that the module met all the criteria included in the fourth factor. This means that the learning objectives found on the multimedia-based instructional module are clearly stated and they provide information to the students on what is expected of them at the end of each lesson. The multimedia-based instructional module also consists of learning activities that are parallel to the learning objectives. The multimedia-based instructional module was also designed with assessment tools that promote more cognitive processing and enable learners to identify what they already know and what they have to know. The result also entails that the learning tasks embedded in the multimedia-based instructional module were motivating to the students. Likewise, the result also implies that the multimedia-based instructional module could cater different types of learners. Furthermore, the result also denotes that the multimedia-based instructional module provided good feedback mechanisms to students in checking their progress. Guido (2014) maintained that modular instruction is based on the principle of learning by doing, wherein the learner study by himself and verifies the correctness of his outputs by comparing it with the answer key which contains the correct answers. Thus, providing immediate feedback.

CONCLUSION AND RECOMMENDATION

Reflecting on the gathered data of the study, the following conclusions are drawn: (1) The development of the multimedia-based instructional module underwent four phases: planning, content validation and analysis, designing, and development. The content of the multi-media based instructional module in Science 7 was developed using the learning competencies marked essential by the evaluators. (2) All of the evaluators agreed that the multimedia-based instructional module in Science 7 met all the criteria found in each factor on the instrument, namely content, design/format, technical/technological, and pedagogy. Therefore, it is concluded that the developed multimedia-based instructional module can be used as instructional material by Science 7 learners. This can help them in attaining the learning competencies designed for their grade level. It is recommended that future researchers may conduct a study that will research the effectiveness of the developed multi-media based instructional module by implementing it. Likewise, the perception of the Science 7 learners about the multi-media based instructional module can also be considered to get feedback in improving the module based on their experience in using it.

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