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Development and Validation of Comic-based Learning Module in Physics

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Abstract

Providing instructional materials that support the diverse learning styles and needs of 21st-century learners is becoming a trend in today's online learning. Thus, this descriptive developmental research design aimed to develop Comic-based Learning Modules (CLM) as instructional material envisioned to meet these learners' needs for a better understanding of Physics concepts. This study employed the ADDIE model for the instructional material development design. The initial developed CLM was revalidated following the comments and suggestions of the validators before distribution for online learning. Four experts validated the CLM in terms of content/lessons, illustrations, additional features, language, layout, and overall presentation using a researcher-made criterion-based reference evaluation tool. The validators rated the developed instructional material featuring three CLM as "Highly Acceptable" (4.66). The value of the average inter-rater reliability coefficient kappa of the ratings of the validators is interpreted as "Substantial Agreement" (0.63). CLM was then implemented as instructional material and found to have high usability as rated by the students. Also, the CLM drew positive feedback for online learning use because of its exciting nature and uniqueness.

Keywords: *ADDIE Model; Comic-based learning module; development and validation; instructional material*

INTRODUCTION

When the Philippine educational system ventured into online learning due to the Covid-19 pandemic, teachers continuously created instructional materials (Cahapay & Rotas, 2020). Instructional materials are tools that could be both visual and audiovisual, which support teaching and learning processes (Tuimur & Chemwei, 2019). To address 21st-century learners' diverse learning styles and needs, teachers put additional effort into creating these instructional materials (Mamolo, 2019). In addition, teachers are tasked to develop instructional materials to ensure students' interesting, meaningful, and enjoyable learning activities as stipulated in the Department of Education (DepED) Memo No. 20, s. 2013 (Aquino, 2019).

The success of students' learning and teachers' teaching heavily relies on the teacher's communication medium (Muzumdar, 2016). Text and visuals are the two media that have been extensively used as instructional aids in teaching and learning (Hosler & Boomer, 2011). Different studies backed the usage of these media, noting that presenting text and visuals together positively influences student learning, information retention, and reading performance (Mayer and Sims, 2004).

One of the most popular forms of media combining visual images with text is comics (Bolton-Gary, 2012). Back in the 1940s, comics as instructional materials and pedagogical tools for teaching and

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learning showed desirable outcomes (Meskin, 2008). McCloud (1994) mentioned that comics are "juxtaposed images which intend to convey information" p.9. According to Hayman and Pratt (2005), comics can only be called "if and only if it is a sequence of discrete and juxtaposed pictures that comprise a narrative when combined with text" p.423. In the early days, comics were art that could be seen in the daily newspaper, sometimes colorful or black and white with words accompanied by images (Versaci, 2001). It had been underrated to be used as a pedagogical tool as people had been reading it primarily for entertainment (Tatalovic, 2009). However, many studies in medicine, art, business, communication, and education proved that comics could also be used as educational tools (Cheesman, 2006).

A body of literature showed that different comics had been developed in science education (Ozdemir, 2017). When creating these comics, two or more images in a series are combined with text to show an idea or story (Trnova et al., 2013). In making the story in comics, images called panel cartoons are combined with text inserted into speech balloons (Arroio, 2011). Comics have been used as a visual medium where panel cartoons are developed to communicate a narrative using text, symbolism, and stylistic art elements to build a subtext meaning (Versaci, 2001).

As the development of different comics as instructional material gained popularity, various comics in science education have been developed (Ozdemir, 2017). One of these is science comics, which primarily aim to communicate science ideas and educate readers about science's fun facts (Bolton-Gary, 2012). Another one is the concept cartoon which was developed to promote teaching, learning, and assessment in science and mathematics (Naylor, 1998). Concept cartoons are single-framed cartoon-style drawings showing thinking individuals interested in science. Meanwhile, a popular form of communicating science through comics in India is called scietoons (Wayulanto, 2006). These comics showed the dialogue between an Indian scientist and a science communicator about different topics in science, like parasitology and the Brownian movement.

Different research studies have been conducted that determine the effect of using comics in science education. A study conducted by Affeldt et al. (2018) found that using comics-based reading materials in science classroom settings motivated learners with low reading abilities to be engaged in reading because of the simple language used and attracted them to learn more about science. In a study by Ozdemir (2017), he noticed that when a comic story was implemented in his science class, it helped achieve long-term learning because of its visual nature. Meanwhile, the study of Yulianti et al. (2016) revealed that using images in comic-based learning material made students more interested in understanding the explanation of scientific facts. Lastly, Lin et al. (2015) showed that in a quasi-experimental study, students who used comic books as a learning material developed enjoyment and interest in learning science compared to those who just used the provided textbook of the school.

In the study of Collver and Weitkamp (2007), 14 science comic creators identified the format of valuable comic-based materials. According to them, there are four facets to consider when making educational science comics. These are the following; comics are (1) visual, (2) narrative, (3) permanent, and (4) approachable. Creators mentioned that underlying all these considerations was the hope that using comics would be a way to reach out to people who might not normally engage with science and better understand scientific concepts.

Research Questions

This study focused on designing, developing, and validating comic-based learning modules (CLM) for Grade 8 students. These CLM were used as instructional material in the current online learning in the Philippines. Specifically, it aims to answer the following research questions:

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1. How is the Comic-based Learning Module (CLM) developed?
2. How did the validators evaluate the CLM in terms of (a) Content/Lessons, (b) Illustrations, (c) Additional Features, (d) Language, (e) Layout, and (f) Overall Presentation?
3. How did the students evaluate the CLM for classroom use in terms of (a) Usefulness; (b) Satisfaction; (c) Ease of Use?

RESEARCH METHOD

Research Design

This study employed a descriptive developmental research design. The ADDIE (Analyze, Design, Development, Implement, and Evaluate) model was used for instructional material development. This study aimed to design, develop, implement, and evaluate comic-based learning modules in Physics for Grade 8 students.

Participants

Four experts in physics education from the public schools in the Philippines were requested to be the validators of the developed CLM. Two intact classes with a total of 68 students in a public school in Cavite, Philippines, ages ranging from 12 to 15 years old, were given the CLM and were asked to evaluate them. These students were still minors. Hence their and their parents informed consent forms were secured before the conduct of the study.

Instrument

The instrument used in this study is the Evaluation Tool for Validating CLM. This instrument is a criterion-based reference evaluation tool developed by the researcher. The researcher's adviser performed the face and content validation of this instrument. This instrument assessed the created comic-based learning module in terms of content/lessons, illustrations, additional features, language, layout, and overall presentation.

Data Gathering Procedure

Development and Validation of CLM using the ADDIE Model

This section provided a detailed discussion of how comic-based learning modules were developed using the ADDIE model.

Analysis Phase - The researcher underwent various steps, such as gathering data by reading different research studies about the development and use of comics in education, specifically in science. Then, the researcher examined the Grade 8 Science curriculum guide for the first quarter to determine the topics included in this quarter. In basic education in the Philippines, science teaching is divided into four branches: biology, chemistry, Earth science, and Physics. Physics is taught in the first quarter of the school year for Grade 8 students. Upon listing the covered topics for the first quarter, the researcher gathered reference materials like the teacher and learner's manual for Grade 8 Physics and other conceptual Physics books. This was done to identify the topics included in the developed CLM and how these should be narrated.

Design and Development Phase - The facets of the comics format framework of Collver and Weitkamp (2007) served as a guide in creating the comic-based learning module. This phase consists of stages: writing the script and drawing the comics.

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Writing of the Script. Upon collecting numerous reference materials needed, writing the script of the module started. Writing of the script followed the narrative and approachable facets of the comics format (Collver & Weitkamp, 2007). The narrative facet of the comics format showed that comics could be used as a storytelling device, and it is a powerful way of communicating physics concepts. It fits well as physics is ultimately the story about how humans have come to understand different phenomena.

The researcher used storytelling to communicate the different concepts about forces, Newton's Laws of Motion, work, and energy in writing the script. A character named Lonzo is the storyteller in the module. In addition, the content of the script contextualizes the concepts discussed in the module. The script was written in a way that readers can engage personally, and it was reflective of the things that happen around us. In this way, students would be entertained and attracted to read the module to relate it to their personal experiences. The script was also written in a way that considers the level of language Grade 8 students can understand and the level of Physics understanding of public-school students. It took almost three weeks to finish writing the script for the module. Upon completing the script, the researcher submitted it to her adviser. The script was revised according to the comments and suggestions of her adviser.

Drawing the Comics. The researcher asked for help from a former Physics classmate in drawing and in designing the comic-based learning module. The layout artist used the Huion tablet with the Photoshop application (*see the interface in Figure 1*) in drawing the images found in the module. The researcher and the layout artist carefully discussed how the illustrations should be drawn to match the final script and be pleasing and enticing to the readers' eyes.

Figure 1. Lonzo, in the interface of the Photoshop application

The visual facet of the comics format was considered in making the final layout and drawings of the module. According to this facet, the visual shown in the module should grab the readers' attention and clarify the concepts that the storyteller would like to communicate. Designing and developing the module took one month. Before the comic-based learning modules were given to students for online learning use, they were initially validated by four Physics education experts. Their comments and suggestions were used to revise the module. The modified material was returned to the validators for

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final rating using a criterion-based reference evaluation tool (*see Table 1*). This was done to assess if the developed material is acceptable for online learning use.

Table 1. Evaluation for CLM

Scale	Interpretation	Description
1	Very Acceptable	The statement is highly evident in the developed comic-based learning module
2	Acceptable	The statement is evident in the developed comic-based learning module
3	Moderately Acceptable	The statement is somehow evident in the developed comic-based learning module
4	Least Acceptable	The statement is not that evident in the developed comic-based learning module
5	Not Acceptable	The statement is really not evident in the developed comic-based learning module.

The final developed module was revised according to their comments and suggestions. The developed comic-based learning module is Newbie Physics: A Basic Physics Comic Book (*see Figure 2*).

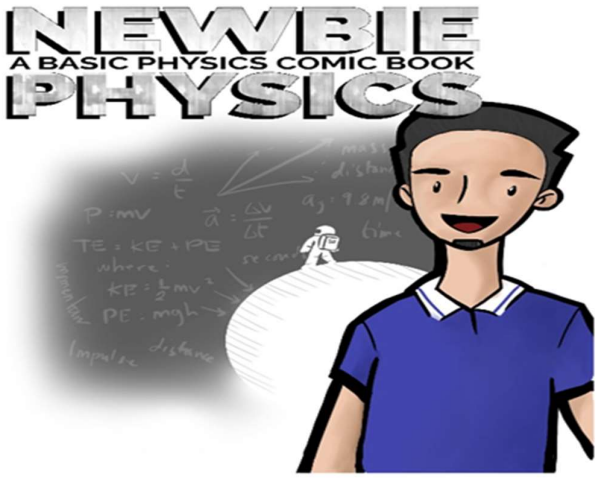

Figure 2. Cover Page

The comic-based learning module has the following parts: Cover Page, Preface, Objectives, Table of Contents (*Figure 3*), Introduction to Physics, Lesson 1 Forces, Lesson 2 Newton's Laws of Motion, and Lesson 3 Work and Energy. The module also has additional features such as the end-of-lesson summary, knowledge-based assessment in the form of crossword puzzles and word hunts, and the life of some well-known scientists in the field of Physics.

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Figure 3. Preface, Objectives, and Table of Contents

Implementation and Evaluation Phase - Two intact classes with a total of 68 students in a public school in Cavite, Philippines, used the CLM for two weeks. After this, the students evaluated CLM using the adapted USE questionnaire developed by Lund (2001). USE is a 5-point Likert-scale questionnaire used to assess the CLM in terms of usefulness, satisfaction, and ease of use. This serves as feedback from the students who used the instructional material.

FINDINGS AND DISCUSSION

This section presents the analysis and interpretation of data gathered from the evaluation of the developed comic-based learning module by the validators and the students.

Comic-based Learning Module Validation Results

Experts' evaluations of the developed comic-based learning module were analyzed using weighted mean, standard deviation, and inter-rater reliability (Fleiss kappa). Table II shows the final evaluation of the validators on the developed comic-based learning module.

The overall mean score received by the developed comic-based learning module is 4.75, interpreted as Very Acceptable with a substantial (0.61) overall agreement from the evaluators. This shows that there is still room for improvement for the comic-based learning module, but it is already in good shape to be used by Grade 8 students as instructional material in physics.

The Content/Lessons criteria received the highest mean score (4.90), interpreted as Very Acceptable with a substantial (0.75) agreement from the validators. This indicates that the content/lessons presented in the developed comic-based learning module are clearly specified, accurate, and correct. The content/lessons are also helpful in developing a better conceptual understanding of Mechanics and are aligned with the set learning competencies for Grade 8. As two of the validators commented:

"I really enjoyed the comics. This material will help students understand the concepts in Physics. The impression of the students towards Physics as a difficult subject will surely change."

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"The content presented in this module matched with the learning competencies for Grade 8. It also matches the level of understanding of the students. It is informative as many examples are given for every lesson."

Figure 4 shows some of the physics content in the CLM.

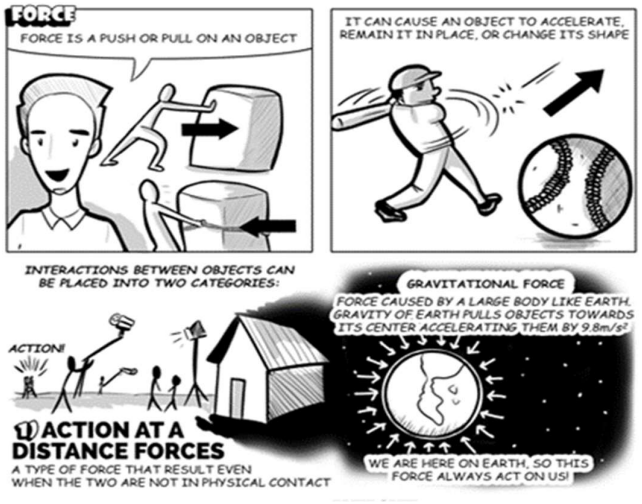

Figure 4. Lesson about Forces

The Illustration and Language criteria both received a mean score of 4.85, interpreted as Very Acceptable, with both having a substantial agreement (0.71) from the validators. This shows that the illustrations in the comic-based learning module are accurate, properly drawn, well-matched with the text, interesting, and attractive to Grade 8 students. Meanwhile, the language used is easy to comprehend, avoids too many technical terms, is free from grammatical errors, and is within the context of Filipino students. As three validators commented:

"The drawings in the module are attractive. The drawings help to understand the written text fully. I am confident that students will enjoy reading the module as I did."

"The illustrations really depict the text. I want to suggest putting illustrations in sample problems to give students a clear understanding of the problem. The illustrations will help students to solve the problem quickly."

"The module's language is free from too many technical terms, so I am sure that students will easily understand it. "

The Additional Features included in the module also got a high mean score of 4.80, interpreted as Very Acceptable but with a moderate agreement (0.50) from the evaluators. This was attained through many changes made to the comments of the validators during the initial validation. As two validators commented:

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"The featured scientists can be related to the topics. If possible, include the story about how the concepts were developed. The practice exercises can be regular to all topics with space for the students to write down their answers."

"Insert a list of concepts tackled in the comics or a summary to be presented in an artistic manner too."

These concerns were addressed by putting practice exercises on all the topics (*see Figure 5*) and by putting enough spaces where students could write down their answers. In addition, a short summary (*see Figure 6*) at the end of every topic was also provided

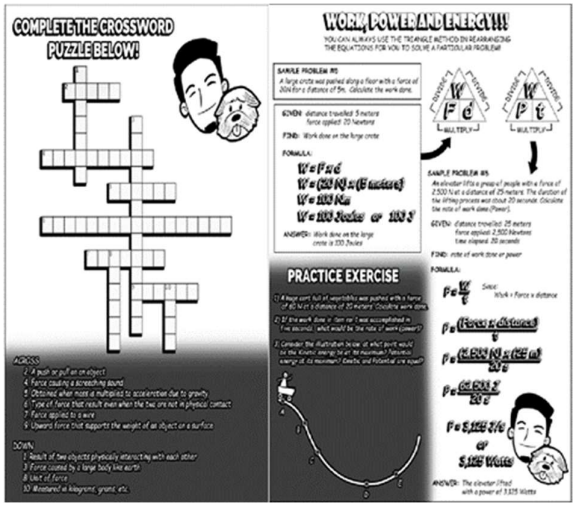

Figure 5. Practice Exercises

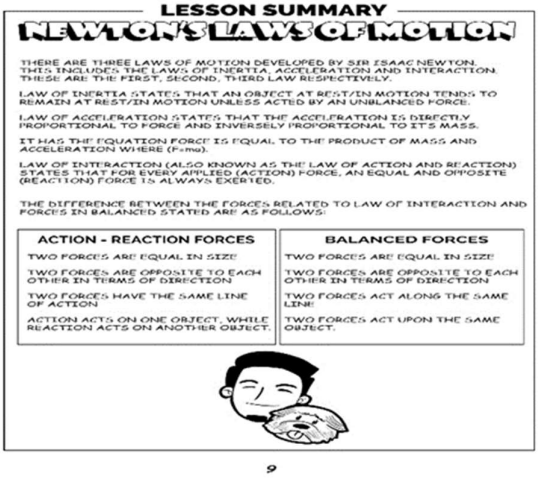

Figure 6. Lesson Summary

The validators substantially (0.62) agreed to give a high mean score to the module's Overall Presentation (4.65). The validators have almost the same judgment that the module is easy, exciting, and attractive to read for junior high school students. It is also appropriate to Physics, shows the ease of reproduction, and minimizes the number of pages. One of the validators commented:

"You may have a digitized version of it so that it may not be a hassle on your part to reproduce it except for the word hunt/ crossword puzzles and exercises (you may request them to do it by group), but you will only upload one comic lesson at a time."

Lastly, the Layout criteria received the lowest mean score of 4.45 but were still interpreted as Very Acceptable with a fair (0.37) judgment from the validators. This showed that the validators have different reviews in the layout of the developed module. One of the validators commented:

"You may add colors to make it more attractive instead of pure black and white."

The researchers would like to consider this suggestion but could not make it due to lack of time. The results obtained in this study agree with Tatalovic (2009), that showed excellent evaluation results in the criteria of comic structure, content, organization, presentation, writing, language, and readability.

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Experts also evaluated the comics developed by Wayulanto (2006), commending that the instructional material was motivating and enjoyable to read.

Students' Evaluation of the Comic-based Learning Module

The Comic-based learning modules were given to students in a portable document format (PDF). Students used this as instructional material that they could read at their own pace. After reading the three developed comic-based learning modules, they were asked to evaluate them using the USE questionnaire.

Table 2 shows the results of the evaluation procedures with the corresponding description of the 68 students who used the CLM in their class during the implementation phase.

Table 2. Students' Evaluation

Dimensions	Mean	SD	Description
Usefulness	4.56	0.59	High
Satisfaction	4.71	0.45	High
Ease of Use	4.49	0.50	High
Overall	**4.59**	**0.51**	**High**

The overall usability of the comic-based learning module, as evaluated by the students, is high (M = 4.59, SD = 0.51). In addition, the dimensions of the usability questionnaire being assessed were also found to be high for usefulness (M=4.56, SD=0.59), satisfaction (M=4.71, SD=0.45), and ease of use (M=4.49, SD=0.51). These results suggest that all the aspects mentioned in the USE questionnaire were covered when the experience using the comic-based learning module.

The result of this validation process is in agreement with the study of Trnova et al. (2013), stating that comic-based material has the potential to convey messages in coherent, clear, and fun ways; and it can improve the enjoyment of reading science due to its humorous nature of narrating science ideas Also added by Cheesman (2006) that comics with the visual appeal of the images can make students think about science concepts and related ideas in a visually entertaining way.

CONCLUSION

This descriptive developmental research aimed to develop Comic-based Learning Modules as instructional material for 68 Grade 8 students in a public school in the Philippines. This study employed the ADDIE model for the instructional material development design. This study showed that the comic-based learning modules featuring discussions about forces, Newton's Laws of Motion, work, and energy were rated as Very Acceptable by the four validators in terms of content/lessons, illustrations, additional features, language, layout, and overall presentation. Students' evaluation of the CLM in terms of usefulness, satisfaction, and ease of use was also found to be high.

The validators view the comic-based learning module as informative, contextual, clear, and directed toward its learning objectives. With this, developing comic-based materials is one of the solutions to the lack of innovative instructional materials that meaningfully connect science content to our daily experiences. Through this, teachers can promote fun ways of learning through reading comics, and students will have an improved understanding of physics concepts. A comic-based learning module served as another way to communicate science ideas in a fun and enjoyable way.

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FURTHER RESEARCH

Other researchers may consider expanding the topics and learning competencies covered in the module. The claims of this study may also be verified by conducting similar investigations but with the use of a different research design, instruments, and grade level of the participants.

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