



Development of Comics Physics Education with STEM for Stimulating Straight Line Motion Concept Mastery in Junior High School Students

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Abstract: One of the lessons that can be used to stimulate mastery of concepts is *STEM* learning approach. This is effective if it is supported by teaching materials in the form of physics comics. Furthermore, the aim of this research development is to produce *STEM-based Physics Comics* products that are valid, interesting, easy, and useful, and effective for stimulating concept mastery in junior high school students. It has been done validity test which are consists of design expert test and material expert test, and the product is valid as to be used. The attractiveness, convenience, and benefit test is conducted by students and the results of attractiveness were obtained by 3.38, convenience with a score of 3.38 and benefit test were obtained 3.31. This research was conducted using *one group pre post design*. The results of *the paired sample t test. Sig value. (2-Tailed)* is less than 0.05 which is 0,000, so it can be explained related to the significant use of *STEM*, on the ability to master students' concepts. Based on the value of *N-gain*, the average *N-gain* of concept mastery ability is 0.43 with the medium category.

Keywords: Comics physics, STEM, master concepts.

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INTRODUCTION

In essence, education is an effort undertaken by the government to improve the human resource capacity in facing 21st-century challenges (Anwar, 2014; Wijaya, Sudjimat, & Nyoto, 2016). Currently, 21st-century human resources must have life skills and career skills, critical and innovative learning skills (Murti, 2013). Learning in the context of preparing for the 21st century refers to the concept of learning that provides experience to learners (Poedjiadi, 2005). Engagement in STEM across the primary-secondary school transition has been widely investigated. However, integrated-STEM implementation had not shown practical packaging and could not reach all the skills that gifted students needed in the 21st century (Abdurrahman, et.al, 2019)

Sciences is one of the subjects taught at the junior high school level. Science consists of Physics, Biology, and Chemistry. Physics is the science or knowledge of nature. Many physics materials have formulas and a series of abstract events that make it difficult for students to understand the material provided, so students are less interested and constrained to understand the material. Based on the description above, it would be more convenient if the physics lessons were delivered in a fun way (Lesmono, 2011).

Some of the potential reasons for developing comics as a learning medium include: (1) junior high school-age children like comics; (2) comics can be read whenever students want them; (3) comics can describe abstract physical phenomena that are not visible; (4) comics convey the contents of the learning message through several characters so students can easily understand the material conveyed (Adinata, 2015).

So far the STEM education movement that has been implemented in developed countries such as Japan, Korea, Australia, and the United Kingdom or developing countries such as Thailand, Singapore and Malaysia, views STEM education as a solution of the problem of the quality of human resources and the nation's competitiveness. Awareness of the importance of STEM education has emerged among education experts in Indonesia where Indonesia itself has not implemented STEM education (Rustaman, 2016).

Based on the results of preliminary research conducted in several schools with a questionnaire distribution method distributed to science teachers and grade VIII students. The results of the analysis of the overall needs of students revealed that 63% of students stated that they needed to develop physics comics while the analysis of teachers revealed that 85% of teachers also stated that they needed to develop comics. Based on the description above, research has been carried out relating to the development of physics comics based *science, technology, engineering, and mathematics* (STEM) to stimulate the mastery of concepts in junior high school students. Furthermore, the aim of this research development is to produce STEM-based Physics Comics products that are valid, interesting, easy, and useful, and effective for stimulating concept mastery in junior high school students.

METHOD

The research design used in this study is *research and development* (R&D). Research and development or better known as *research and development* (R&D) are a research method that is widely used in educational research. According to Sugiyono (2012: 407), research and development methods are research methods used to produce a particular product and test the effectiveness of the product. This research is conducted using *one group pre post design*.

Research Design & Procedures

The development procedure is held to refer the process of instructional media development by Sadiman et al. (2006: 39). The flowchart of the instructional media development process can be seen in Figure 1.

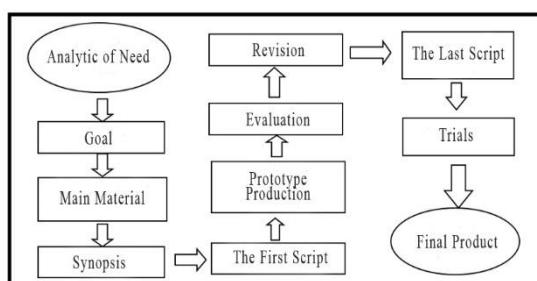


Figure 1. the instructional media development process (Sadiman, 2006).

Population and Sample

Sampling was done by using purposive sampling technique. This study takes the majority of the population to be sampled by background have average academic ability equal. This research was conducted at SMPN 3 Terbanggi Besar, Lampung, in class VIII G.

Data Analysis

The test conducted in this research was a validation test consisting of a design expert test and material expert test, a small group test and an effectiveness test. The results of this study use *the paired sample t* test and the *N Gain* test. For effectiveness testing using the results of pre-test and post-test and N-gain is calculated to determine how far the mastery of students' concepts.

RESULT AND DISCUSSION

Characteristics of Comics as Science Teaching Materials on Straight Motion Material. The Conversation and storylines that made the developer adjusted for age readers in general. The contents of the comic tell about the massive dialogue on straight motion in the form of speed, speed, distance, displacement, and acceleration, then tells about the understanding of straight motion which is then divided into two, namely Straight Motion Regularly (SMR) and Straight Motion Changed Regularly (SMCR) and

simulating experiments. This comic also contains question exercises. In addition, the illustrations of images and conversations used in comics are easily understood and in accordance with the facts of everyday life. Stories and messages conveyed through pictures are displayed in the form of panels. This is in accordance with the opinion of Novianti, et al (2009) which states that comics are made with concise and interesting stories, stories on comics about themselves so that readers can immediately identify themselves through the feelings and actions of the character of the main character. This is consistent with the findings of Hidayah, et al (2016) which states that comics are one of the teaching materials that are designed to resemble learning modules that can be used as learning resources. The material contained in the comic is in the form of a story line accompanied by pictures and writings that support each other's existence. This can make it easier for students to understand what is being explained. The storyline in the form of pictures and writing is certainly related to the material in question, it's just designed to be more interesting so students are interested and not bored while studying.

The characteristics of the physics comic that have been developed have the following STEM characteristics:

1. Science as a Process

In this section, students are guided to observe, ask questions, try, associate, and communicate a phenomenon that occurs in everyday life.

2. Technology as Application of Science

In this section, students are given the "Physics Application" which aims to facilitate students in understanding technology related to the concept of straight motion that is often encountered in daily life.

3. Engineering as a Science of Engineering

In this section, students are given a broader understanding of the engineering procedures of engineering design. The aim is to provide students with provisions when dealing with perspectives on how the analyse series.

4. Mathematics as a Tool

In this section, students are invited to model their own mathematical formulas in straight-motion material.

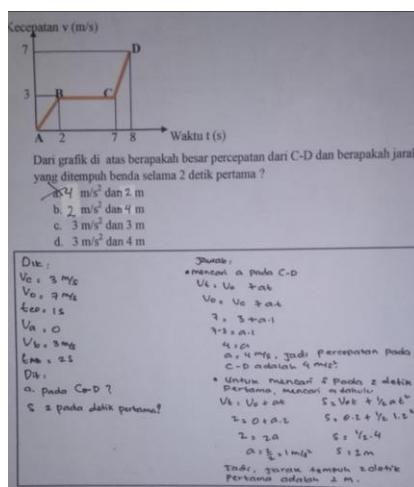


Figure 2. Analysis of Mathematics

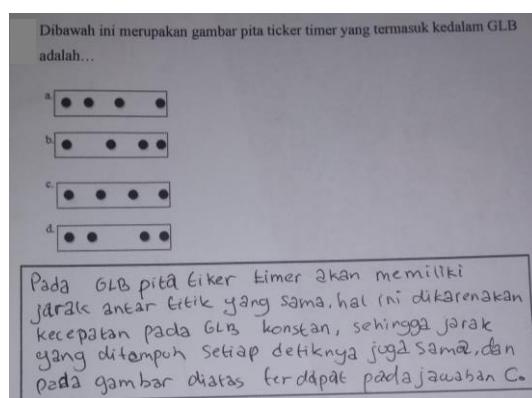


Figure 3. Analysis Concept of Science

STEM activities, the students should be encouraged to create their own visual form to the representation of the basic concepts that are focused on problem-solving or production of the product, including the application of engineering design process, e.g., expression, creation, testing, repair (Blackley et.al 2018). The Result of Validity Test. The result of validity test can be seen in table 1

Table 1. The Result of Validity Expert Test

No	Aspect Assessed	Examiner Score	Qualitative Statements
1	Material Expert Test	3,57	Very Valid
2	Design Expert Test	3,68	Very Valid

Based on the results the validity of the product in the material aspect showed a good result with the score of 3.47, which means the result was in a high category. The developer also tests the design expert to determine the level of interesting product being developed. Based on the test results the developer design expert obtained a validity score of 3.62. The score obtained is included in the classification is very valid, which is in the range of scores 3.26 - 4.00. This is in line with research conducted by Widyawati (2015) which states that the feasibility of media comic science is based on the research of media experts, material experts, educators, and peers with very good criteria.

The Result of One on One Test

The results of the one-on-one test questionnaire analysis can be seen in Table 2

Table 2. The Result of One on One Test

No	Aspect Assessed	Examiner Score	Qualitative Statements
1.	attractiveness	3,38	Very Good
2.	Ease Using	3,38	Very Good
3.	Benefit Using	3,31	Very Good
Total		3,37	Very Good

The developer does a one-on-one test to find out the attractiveness, ease and benefit using of the comics that were developed. Based on the results of one-on-one tests, the developer obtained a score for the attractiveness test of 3.38, for the ease using test obtained a score of 3.38 and for the benefit test a score of 3.31 was obtained. The scores obtained are in the range of scores of 3.26 - 4.00 so it can be concluded that the comics produced are interesting, easy and useful. Based on students' comments when doing one-on-one test, students feel very interested in reading comics that were developed. This is caused the comic not only invites students to learn straight motion material, but also invites students to follow the excitement of the character's adventure story in uncovering a mystery in the straight motion material.

This is consistent with the opinion of Aslamiyah (2017) which states that students' responses to comic media are considered to be very good because comics are considered easier to understand and more interesting than the books used. The Result of *n-gain* score can be seen in Table 3

Table 3. The Result of N-Gain score Concept Mastery Ability

Σ Score		Σ Score <i>N-Gain</i>	Class Criteria
Σ Pre-test	Σ Post-test		
45,48	68,71	0,43	Medium

Data on the results of the pre-test and post-test answers were then analysed to determine the increase in mastery of concepts using n-gain. Based on the n-gain value with the help of Microsoft Excel, the n-gain score of 0.43 is obtained with medium criteria. Based on the n-gain value obtained, it can be concluded that the comics that have been valid can increase the mastery of student concepts.

Testing the improvement in students' concept mastery ability is done using paired sample t test with the help of the SPSS 22 program. The results of paired sample *t* test can be seen in Table 4.

Table 4. The Result Paired Sample T Test

Data	Average difference	t	df	Sig
Posttest	23,226	21.578	30	0,000
Pretest				

Based on the paired sample *t* test results obtained sig. of 0.00 which means there is an increase in the mastery of students' concepts after using STEM-based physics comics. It can be seen in the value of sig. obtained <0.05 so that H_1 is accepted. The average increase in mastery of students' concepts is 23,226.

Hypothesis testing is done using paired sample *t* test with the help of SPSS 22 program. Based on paired sample *t* test, sig values are obtained of 0.00 which means there is an increase in the mastery of student concepts after using STEM-based comics. It can be seen in the value of sig. obtained <0.05 so that H_1 is accepted. The average increase in concept mastery is 23,226.

Teaching material in the form of STEM-based comics that have been developed can improve the mastery of the concept of science. Acquisition is in accordance with the

opinion of Zuhrowati, et al (2018), Noveri, et al (2011), Aldila, et al (2017) and Adinata, et al (2015) who state that science learning comics are effectively used as a medium for learning Physics in schools. This is in accordance with Komarudin (2016) which states that the use of STEM-based teaching materials is able to increase the mastery of students' concepts in the medium category, better than the use of non-STEM teaching materials in the low category STEM learning implemented through STEM-based teaching materials makes students more easily understand concepts with the help of visualization of concept animations, the use of STEM-based teaching materials can be applied in science learning in junior high schools with the aim to improve and increase students' cognitive learning outcomes, because the learning can help students in constructing their own instruction, overall the results obtained provide a pretty good picture of how STEM-based learning is can improve mastery of students' concepts.

This is also in line with the opinion of Abdurrahman (2015) the integrated application of STEM indirectly requires students to think creatively. The teaching materials used greatly affect the learning outcomes of students. This is also in line with the opinion of Sulistiawati et.al (2018) Based on the results of the interview, the students felt happy to learn by using the STEM-based worksheet. It helps them to gain a better understanding. The worksheet presents pictures, phenomenon, and discourse related to daily life and the activities in the worksheet are also arranged in sequence. With the STEM based worksheet, the students' understanding taught is related to daily life. Acquisition is in accordance with the opinion of Listiana et.al (2019) the students taught using the STEM approach are in the "conceptual" category which is more in explaining the concept. This is in line with research conducted by Widayanti et.al (2019) In the future, there needs to be the development of STEM-based teaching materials to support the national curriculum that is designed to the maximum.

CONCLUSION

Based on the results of research and discussion by the aithor, the following conclusions can be concluded. The comic developed contains a dialogue that tells about the amount contained in straight motion, the understanding of straight motion, simulations of straight motion practicum using the STEM approach. This comic contains question exercises and character adventures. Based on the results of the validity test, the comic produced is very valid, Based on the results of the one-on-one test, the comics produced are interesting, easy and useful, Comics on straight motion material developed effectively used as a medium of science learning can be seen from a significant increase in the average learning outcomes at 95% confidence level and the N-gain value obtained at 0.43 with moderate criteria.

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