Implementation of mathematical comic on exponent and logarithms with 21st century skills - oriented

A cahyono¹, Isnandar¹, B Usodo¹

¹ Postgraduate of Mathematics Education, Universitas Sebelas Maret, Surakarta, Indonesia

e-mail : ariscahyono79@gmail.com

Abstract. In learning activities, teaching materials are very important for teachers and students. Teaching materials are very important things to be developed as an effort to improve the quality of learning. Research method used in this research is Research and Development, which aims to produce products, namely teaching materials in the form of mathematical comics on exponent material and logarithm of class X vocational high schools (SMK), knowing the feasibility, practicality and effectiveness of the comics produced. Comic teaching materials are validated by media expert lecturers, material expert lecturers, and teachers. The feasibility questionnaire instrument for comic teaching materials is given to media experts, material experts, teachers and students. The effectiveness test was carried out on the experimental class using comic teaching materials and control classes that did not use comic teaching materials. Data was analyzed using t-test. The results of this study indicate that there are differences in learning outcomes between the experimental class and the control class. The experimental class provides better learning outcomes than the control class. Teaching materials using comic effectively used in learning class at vocational high schools.

1. Introduction

There are many factors that influence student success in learning, among them are teaching materials. Material presentation should be packaged in an interesting manner so that it can arouse student motivation and be able to make students understand the material. One way to present material is to use learning media that are interesting and easily understood by students. The learning media developed are learning media in the form of mathematical comics, because of their uniqueness as learning media and entertainment media. Comics as visual media are able to give effect to the acquisition of student knowledge as a result of learning, because comics can attract students' interest and attention in receiving information. Comics are an attractive choice to be a learning medium because the emotional involvement of the reader will greatly affect the memory and memory of the material being studied [1]. "Comic" come from a Greek word, that is "komoidia or comedy". Comics use images that are equipped with words that are often combined with humorous sentences and can be found in various contexts, such a newspaper. Though similar types of artistic approaches could include cartoons which usually involve drafts of animation, or graphic novels and a much more detailed story of episode. Comics can facilitate students to learn concepts as a whole, such as cognitive development, information processes and motivation [2]. Comic strips can be defined as a series of images in a box that tell a continuous story [3]. Comics can be used to build positive affective contexts and interests in teaching theory and and learning, and encourage students to continue to reflect and think critically about best practices for learning and engagement [4].
Comic is a series of pictures included in the box that contains a whole series of a story. The pictures are usually equipped with greeting balloons accompanied by narrative explanations [5]. Comics, whether they are digital media based on traditionally printed on paper, generally belong to the media world of the younger generation, the popularity of the comics has been suggested as a cause of both the higher visual literacy and a decline in students' current reading ability [6]. Educational comics can support the understanding of abstract concepts better than a long text written in more-or-less strictly scientific language, comics allows teachers to combine text and art in order to make an effective pedagogical tool and teaching science via comics by telling a gripping adventure story makes the information more motivating to students [7]. Some of the benefits of using comics according Rothlein and Meinbach: (1) can provide language appreciation and develop oral communication, (2) can develop the process of cognitive thinking, (3) expressing feelings and increasing art sensitivity, (4) impresses long lasting in memory, fosters students' interest in reading, and fosters a more concrete understanding [8].

Exponents and logarithms are one of the mathematical material that is considered still difficult for students in class X of SMK. The basic competency to be achieved in logarithmic material is that students can determine logarithmic results and solve everyday problems related to logarithms. Student's ability to determine the results of logarithms and solve contextual problems related to logarithms is still relatively low, this can be seen from the results of the PAMER UN, of 158,778 students in Central Java, only 52,492 students were able to simplify the form of logarithms and their results, while 106,286 students have difficulty in simplifying the logarithm form and results.

Along with the development of the era, the 21st century is a century where the development of science and technology has grown rapidly. Thus, the learning used must be able to meet the demands of the times. Teaching the 21st century is expected to be able to produce human resources, especially teachers and students who can master various forms of 21st century skills. The result publication of Educational Testing Service (ETS), Digital Transformation: A Literacy Framework for ICT Literacy (2007), defines 21st century learning skills as the ability to a) collect and retrieve information, b) organize and manage information obtained, c) evaluate the quality, relevance and usefulness of the information obtained, and d) produce accurate information through the use of available resources [9]. The types of skills are grouped into three, (1) learning and innovation skills consist of critical thinking and problem solving, communication and collaboration, creativity and innovation, (2) digital literacy skills consist of information literacy, media literacy, information and communication technologies (ICT) literacy, (3) career and life skills consist of flexibility and adaptability, initiative and self direction, social and cross cultural interaction, productivity and accountability [10].

The 21st Century skills identify 21st century skills as a critical thinking and problem solving, communication, collaboration, and creativity and innovation – more commonly known as 4C skills [7]. From the 4C that has been mentioned, the research used is creativity and innovation. Creativity is a person's ability to generate new ideas from existing ideas. A person's creativity depends on the level of one's creative thinking to create new ideas that lead to new discoveries and are often called innovations. Characteristics of Innovation Creativity and Skills include, (1) being able to develop, apply and convey new ideas to others new discoveries and often called innovations, (2) open and responsive to seeing new and different views, (3) using technology to make a decision, solve a problem, and create new ideas [11].

In this study, the teacher develops mathematical comics as a form of creativity in 21st century skills are very relevant because students students will not be bored with existing teaching materials. Some result studies using mathematical comics include: (1) comics have the potential to increase student motivation and personal involvement when dealing with scientific problems [12], (2) all students use the effects of comic strips, regardless of proficiency and the level of text performs better than students who do not use comic strips [13], (3) comics can facilitate students to learn concepts as a whole, such as motivation for cognitive development and information processing [3], (4) the teaching done with cartoons positively influences student achievement and knowledge [14], (5) educational comics could be used to cultivate a positive attitude of the students since it improved the students'
literacy [15], (6) teaching materials using comics media more effectively used in learning class at vocational schools [16], (7) comics can be used as an alternative to replace student worksheets. The storyline in comics is more interesting than student worksheets, so that this can be effective in preventing student boredom in learning [17].

2. Method
The type of research used in this study is research and development (RnD). Instrument development includes preliminary studies, product development, product testing and efficacy, and dissemination and implementation. The preliminary study consists of three steps, literature review, needs analysis, and preliminary research. The development phase is a combination of the planning stage, product draft development, trial and product revision. The testing phase of product efficacy is the final product in the form of mathematical comics on exponent material and logarithm of class X SMK. Finally, the presentation of an article about comics was made at an international conference (figure 1).

This research was conducted at SMK Negeri 2 Surakarta. Of the several classes available, randomly selected two classes were selected as the experimental class and the control class. Sample of this research is 32 students class X Computer and Networking Engineering (TKJ) A of SMK Negeri 2 Surakarta as experimental class and 32 students class X (Software Engineering) RPL A of SMK Negeri 2 Surakarta as control class.
Learning in the experimental class uses mathematical comics, while learning in the control class is conventional learning. Before mathematical comics were tested in the experimental class, they were first validated by media experts.

| Table 1. Validation of Media Expert |
|------------------------------------|
| Validator      | Validation 1 | Validation 2 | Categories  |
|----------------|--------------|--------------|-------------|
| 1. Astri Carolina, S.Kom. M. Cs   | 75.00 %      | 82.41 %      | Very good   |
| 2. Eko Feriyanto, S. Kom          | 80.56 %      | 84.26 %      | Very good   |
| 3. Andi Novianto, S. Kom, M.H, M. Kom | 76.85 % | 86.11 %      | Very good   |

Result in table 1 shows that the validation by media expert. Assessment is carried out by media experts twice including revisions related to the problems of the contents, such consistent in font size, practice questions are made more interesting, the title of the size type is enlarged, etc. From the final results of the validation by media experts, it shows that including the category is very good, this means that the comic is suitable to be used.

Method of data collection in this study consisted of documentation methods and test methods. The documentation method includes the national exam scores in SMP which are used as preliminary data. The test method was used as the final test after the experimental class was treated. The final test is given to exponent and logarithms material. The test instrument used consisted of 20 items that were validated by two mathematics teachers who have obtained master's degrees in mathematics education and mathematics lecturers from Veteran Bangun Nusantara University. This is then tested in class X Computer and Networking Engineering (TKJ) C of SMK Negeri 2 Surakarta and analyzed. Analysis instrumen of the trial results consists of discrimination power (DP), difficulty level (D), and reliability test with Kuder–Richardson – 20 (KR-20). Of the 30 questions that were tested, 20 questions were feasible to be used as final test questions. Kuder-Richardson formula 20, or KR-20, is used to test the reliability of a question with the right answer (1) or wrong (0). Reliability refers to how consistent the results of the test are, meaning how well the test measures what you really want to measure.

The question is said to be good if it has a discrimination power (DP) of more than or equal to 0.30 (DP ≥ 0.30), the level of difficulty (D) is 0.30 ≤ D ≤ 0.70 and the reliability index (r11) is greater than or equal to 0.70 (r11 ≥ 0.70). The results of the instrument analysis, out of 30 items, were obtained 20 items that were said to be good because they qualified for the discrimination power and the level of difficulty. The result of reliability value from the 20 items, r11 = 0.7158. Obtained r11 = 0.7158, meaning that the results of measurements that have a reliability index (r11) of 0.70 or more of the instruments can be used for measurement or 20 items can be used as a final test. The data analysis used in this study is the t-test by taking a significance level of α = 5%, by comparing two learning models (using comics and conventional).

3. Result and Discussion

3.1. Preliminary data analysis

In this section an initial data analysis will be presented. Preliminary data is obtained from the results of the national exam final exam scores in junior high school. Table 2 shows the results of the normality test using the Liliefors method in the experimental class and control class.

| Table 2. Test the normality of the initial data |
|-----------------------------------------------|
| Group         | L−obs | N  | L0.05;32 |
|----------------|--------|----|----------|
| Experimental Class | 0.0869 | 32 | 0.1566   |
| Control Class      | 0.0921 | 32 | 0.1566   |

Table 2 shows that the experimental class obtained L−obs = 0.0869 and the control class
L_\text{obs} 0.0921. L_\text{obs} is obtained from the results of the national exam scores of students in junior high school. The results of the national exam scores are then sorted from the smallest value to the largest value, then tested by the Liliefors method. From the results of the normality test, obtained in experimental class of L_\text{obs} = 0.0869 and control class obtained of L_\text{obs} = 0.0921 then L_{0.05; 32} = 0.1566. L_\text{obs} of the experimental class (0.0869) and L_\text{obs} control class (0.0921) is less than L_{0.05; 32} (0.1566), it's means the two classes are normally distributed or normal population.

The t-test can be used in data for two independent samples, a random sample of normal distribution, and only 1 dependent variable. Table 3 shows whether there is a difference between the experimental class and the control class.

**Table 3. Description about initial abilities between the experimental class and the control class**

| Group            | N  | Mean  | DS    | t-obs | t_{0.025; 62} |
|------------------|----|-------|-------|-------|---------------|
| Experimental Class | 32 | 75.7031 | 15.6606 | 0.2201 | 1.998         |
| Control Class    | 32 | 74.9531 | 11.2403 |        |               |

From the t-test shows that t-obs = 0.2201 and t_{0.025; 62} = 1.998 (t-obs = 0.2201 < t_{0.025; 62} = 1.998). It’s means there is no difference between the experimental class and the control class, that the two classes have the same initial abilities. Furthermore, learning in the experimental class uses comics as a form of creativity from 21st century skills, while in the control class with conventional learning.

### 3.2 Result

Table 4 shows the results of the normality test for the final test between the experimental class and the control class. The data used for the normality test are the results of the final test score in the experimental class and the control class on exponent and logarithms material.

**Table 4. Normality test**

| Group            | L_\text{obs} | N  | L_{0.05; 32} |
|------------------|--------------|----|--------------|
| Experimental Class | 0.1052       | 32 | 0.1566       |
| Control Class    | 0.1209       | 32 | 0.1566       |

From table 4, shows that the results of L-obs in the experimental class (0.1052) and the control class (0.1209) are less than L_{0.05; 32} (0.1566), this means that the final test results are normally distributed.

Table 5 describe the results of the t-test from the final test results on exponent and logarithms material. The data used for the t-test are the results of the final test score in the experimental class (after using comics) and the control class on exponent and logarithms material.

**Table 5. t-test after experimental**

| Group            | N  | Mean  | DS    | t-obs | t_{0.025; 62} |
|------------------|----|-------|-------|-------|---------------|
| Experimental Class | 32 | 70.7813 | 16.5641 | 2.0628 | 1.998         |
| Control Class    | 32 | 61.8750 | 17.9493 |        |               |

Based on table 5, it shows that t-obs (2.0628) is higher than t_{0.025; 62} (1.998). It’s means that there are differences in the final test results between the experimental class and the control class. From the results of the t-test, it can be concluded that there are differences in student learning outcomes between the experimental classes that use comics on learning with the control class using conventional methods. The experimental class produced a better final test than the control class, because in the experimental class students were more interested in reading comics so they were motivated to learn.
Table 6. Table Revised of Media Experts Assessment

| Validator          | Input                                                   | Revision                                      |
|--------------------|---------------------------------------------------------|-----------------------------------------------|
| Media Expert       | 1. Font size to be consistent                           | 1. Correct font size that have not been consistent |
|                    | 2. In practice questions, the display is made more     | 2. Improve the appearance of the problem exercise |
|                    | attractive                                              |                                               |

Table 6 shows that After validation by media experts, mathematical comics still need to be corrected for letter size and also in the appearance of the problem training. For this reason, mathematical comics have been made in accordance with improvements directed by media experts. After improvement, students can understand the material exponents and logarithms are better than before. That is, students who in learning to use comics can produce better achievements than students who do not use comics during learning.

From figure 2 shows that the font size is not consistent. After being validated by media experts (figure 3), then the size of the letters is made the same, so that it can be read easily and clearly.

4. Conclusion

Learning with mathematical comics in the form of creativity from 21st century skills can improve student learning outcomes compared to conventional learning. Learning by using comics can cause students not to get bored because they can put forward new ideas using mathematical comics. Students are more confident to express their opinions because of mutual respect between them. From the results of this study, the author suggested that learning with mathematical comics of the form of creativity from 21st century skills can applied in the learning of exponents and logarithms. Suggestions from the results of this study, that learning with comics can be developed on other material, not only limited to material exponents and logarithms. Learning by using comics can also be applied to other subjects to be able to improve students' ability and willingness to read.
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