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Development of Comic Integrated Student Worksheet to Improve Critical Thinking Ability in Microscope Material

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Abstract. This study aims to develop an integrated comic student worksheet to measure the ability to think critically on microscope material. This research is a development research. The software used in designing or developing comic products is PicsArt. The results of this study are; (1) the distribution of the ability of students in the modelling class on average is in good category. (2) the distribution of the ability of students in the implementation class on average is in very good category. This indicates that the comic integrated student worksheets can help students understand physics learning.

Keywords: Comics; Student worksheets, Microscopes; Critical thinking.

1. Introduction

Education is a very important thing in human life. The aim of National Education has always been a guide to the implementation of education in Indonesia and various policies adopted by the government in the field of education in Indonesia. Starting from the improvement of educational tools to improving the quality of education through efforts to professionalize educators or teachers. An integrated and earnest effort is needed in steps to increase the intelligence and learning motivation of students who become the initial capital of students. Learning media that is widely used by teachers are student worksheets, media made by teacher-made slides, lesson textbooks, and learning videos. Although there are many types of learning media, there needs to be additional new alternatives that are more innovative and able to attract students' attention [1].

Physics in high schools often contain abstract concepts. Abstract concepts cause difficulties in understanding by students and require high imagination [2]. The complexity of the teaching materials delivered makes students less interested in reading textbooks including physics books. Students tend to be interested in reading picture books (such as comics) [3]. Physics is more fun when packaged in the form of illustrated comics, especially in visualizing abstract concepts. Images can overcome space and time constraints because not all objects, objects or events can be brought to class, and children cannot always be brought to the object / event [4].

Comic creations in the classroom show that enjoying science can bring students to the scientific concepts and values that students will do in class [5]. Comics stimulate and encourage the process of thinking, discussion and development of communication skills [6]. The use of comics motivates students to think and discuss their ideas and relate them to their surroundings [7].

Comics are a great tool that includes entertainment elements that encourage critical thinking of students' main ideas [1]. The entertaining element also motivates students to laugh and comment funny, which is important in enhancing students' interaction with the idea of comics and encouraging



students' brains to think deeply about problems. The use of comics has a positive effect on students' awareness because it is able to enrich the learning environment and create a learning environment that focuses on students. The use of comics motivates students to think and discuss their ideas and relate them to their surroundings [2].

Physics learning in schools should be oriented towards students. Students must learn to get their own physics [8]. So, students must be involved in learning activities. Therefore, the learning model used in conveying the concept of physics must be in accordance with the physical characteristics and in accordance with the 2013 curriculum that applies today.

Learning media that is often used by teachers in learning activities is LKS, media by teacher-made presentation slides, textbooks, and learning videos. Although there are many variations of the types of learning media that already exist, but the need for alternatives that are more innovative and can attract the attention of students in the process of learning, one of which is developing comic learning physics.

The entertaining element also motivates students to laugh and comment funny, which is important in enhancing students' interaction with the idea of comics and encouraging students' brains to think deeply about the problem [9]. The use of comics has a positive effect on students' awareness because it is able to enrich the learning environment and create a learning environment that focuses on students. The use of comics motivates students to think and discuss their ideas and relate them to their surroundings [7].

The creation of comics in the classroom shows the possibility of enjoying physics because it brings students to what scientific concepts and values students can do in class [5]. Comics can be used to learn great effects by simplifying difficult concepts and entertaining them.

Critical thinking is an important skill needed in the world of work in the 21st century (Essential Skills for the 21st Century Workplace, 2014). This skill even ranks first in the list of skills needed. AAC & U survey in 2009 showed that 74% of respondents stated that critical thinking is at the core of learning goals in campus education programs [10]. These high thinking skills include analytical, synthesis and evaluation skills [11].

Critical thinking tests are developed based on the conception of critical thinking. This test aims to develop a high-level thinking ability possessed by someone [12]. The development of critical thinking skills needs to be developed in students, so that students more easily understand the concept, and sensitive to the problems that occur. Critical thinking is not only developed in learning, but also must be supported by a test tool that reflects critical thinking [13]. This is because the test is a part that integrates with classroom learning.

In this paper, physical comics are developed in the form of student worksheets and act as supplement in learning. The comic discusses the material of microscope optical instrument physics for class XI SMA. The validated comics have been validated before being used in the learning process.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method

This research includes the classification of research and development. This research was conducted in May 2018 with a location in one of Yogyakarta State High Schools. The subject of the study consisted of students of Yogyakarta Public High School class XI. The trial subjects involved 15 students of class XII. The research subjects at the field trial stage were all students of class XI 2 totalling 32 students.

This study produced physical comic products in the form of student worksheets. The research method used in this study is research and development (R & D) research and development methods. The development model used is 4-D which is divided into several steps namely Define, Design, Develop and Disseminate.

After the instrument is assessed by experts, the results of the assessment are tabulated and calculated using the Aikens V formula to see the results of its validity. the following steps and similarities.

- a. Tabulation of all data that has been obtained from the validator
- b. Calculated by the Aiken's V equation and the equation

$$V = \sum s / [n(c - 1)]$$

Where:

$$s = r - lo$$

lo = The lowest validity assessment number (in this case 1)

c = The highest validity rating (in this case 5)

r = The number given by a validator

The next step is to compare the value of Aiken's V with the quality category (see Table 1).

Table 1. Product Criteria

No	Interval Score	Quality category
1	$0,8 < V \leq 1$	Very Good
2	$0,6 < V \leq 0,8$	Good
3	$0,4 < V \leq 0,6$	Moderate
4	$0,2 < V \leq 0,4$	Low

After getting the results of the validity, the reliability test is continued by using the Borich Test. The presentation scale with two assessors uses the following equation (1) adopted from [14].

$$R = \left(1 - \frac{A - B}{A + B} \right) \times 100\% \quad (1)$$

Where

R = Presentation Scale

A = Observer of great value

B = Small value observer assessment

The results of the assessment of learning devices and student responses were analyzed descriptively. The data generated in the form of a Likert scale was changed in quantitative form. after obtaining quantitative data the data is processed in the form of an actual score stating the validity value of the product that has been validated. Classification based on a comparison of the ideal score average (X_i) and the ideal standard deviation score (S_{Bi}). The qualification level is divided into four categories with the following criteria shown in Table 2.

Table 2. Score Classification

No	Average score interval	Quality category
1	$X \geq X_i + 1,8 S_{Bi}$	Very Good
2	$X_i + 0,6 S_{Bi} \leq X < X_i + 1,8 S_{Bi}$	Good
3	$X_i - 1,8 S_{Bi} \leq X < X_i + 0,6 S_{Bi}$	Moderate
4	$X < X_i - 1,8 S_{Bi}$	Low

The ideal average score (X_i) and ideal standard deviation (S_{Bi}) can be determined by the following formula:

$$X_i = \frac{\text{Skor maksimum ideal} + \text{Skor minimum ideal}}{2}$$

$$S_{Bi} = \frac{\text{Skor maksimum ideal} + \text{Skor minimum ideal}}{6}$$

The ideal maximum score is the theoretical ideal highest score of all statement items and the ideal minimum score is an assumption if the entire sample gives the lowest response.

3. Results and Discussion

Assessment of students' worksheets is reviewed based on didactic aspects, suitability of students' worksheets to measure critical thinking skills. Based on the assessment of two experts, the V Aiken index value was obtained with 20 indicators. The developed student worksheets were shown in Table 3.

Table 3. V Aiken Index Validation of student worksheets

Indicator	Aiken V	Category
Didactic Aspect		
1	1.00	Very High
2	0.50	Moderate
3	1.00	Very High
4	0.50	Moderate
5	0.67	High
6	0.67	High
7	0.67	High
8	0.67	High
9	1.00	Very High
10	1.00	Very High
11	0.67	High
12	0.67	High
13	0.67	High
14	0.67	High
15	1.00	Very High
16	0.67	High
17	0.67	High
Suitability of Student Worksheet to Measure Critical Thinking Ability		
18	0.83	Very High
19	1.00	Very High
20	0.67	High
Rata-rata	0.76	High

Based on the V Aiken index value data that is obtained as a whole the indicator is in the interval 0.60-0.80, then the students' worksheets that have been developed have high validity and can be used. Assessment of Teaching and Learning Plan (RPP) is reviewed based on the aspects of Formulation of Learning Objectives, Presentation of Content, Language and Time. Based on the assessment of two experts, the V Aiken index value obtained from the indicators developed is shown in Table 4.

Table 4. V Aiken Index Validates RPP

Item	Aiken	Category
Formulation of Learning Objectives, Content Presentation		
1	1.00	Very High
2	0.75	High
3	0.63	High
4	0.75	High
5	0.88	Very High
Content Presentation		
6	1.00	Very High
7	1.00	Very High
8	0.75	High
9	0.75	High
10	0.75	High
Language		
11	0.75	High
12	0.75	High
13	0.75	High
Time		
14	1.00	Very High
15	0.75	High
Rata-rata	0.82	Very High

The ability to think critically of students is measured using the Student Worksheet. The test is carried out after students carry out the learning by using the worksheets of the integrated comic material of the Microscope material. The research was conducted in the modelling class (see Table 5).

Table 5. Descriptive analysis of critical thinking skills in terms of the results of the Student Worksheet of Modeling Class Students

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Score	26	44.40	88.80	67.62	11.70	136.93
Valid N (list-wise)	26					

The results can be shown in Table 6, that the general description of the maximum ability to think correctly after using the integrated comic student worksheets is 88.80 and the drinking score is 44.40 with an average critical criterion of 67.62 and a standard deviation of 11.70. In Table 5. also obtained the value of variance for critical thinking ability is 136.93. The most critical frequency thinking ability is in the ability of 62,14-73,26 with frequency 12, for the range of 75,48-88,0 as many as 8 smallest frequencies and frequencies in the range of 44,40-59,94 has a frequency of 6.

Table 6. Distribution of Critical Thinking Ability of Modeling Class Students

Sales ■ 1st Qtr	Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
	44.40	2	7.7	7.7
Valid	51.06	2	7.7	15.4
	59.94	2	7.7	23.1

62.14	4	15.4	15.4	38.5
66.60	4	15.4	15.4	53.8
73.26	4	15.4	15.4	69.2
75.48	2	7.7	7.7	76.9
77.70	4	15.4	15.4	92.3
88.80	2	7.7	7.7	100.0
Total	26	100.0	100.0	

Research conducted in the implementation class uses things that are not different from the modelling class. Students' ability to think critically using student worksheets (see Table 7). The test is carried out after students carry out the learning by using the worksheets of the integrated comic material of the Microscope material.

Table 7. Descriptive analysis of critical thinking skills in terms of the results of student worksheets

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Score	25	42.18	84.36	64.20	10.00	100.17
Valid N (list-wise)	25					

The general description of the maximum ability to think correctly after using the comic integrated student worksheets is 84.36 and the drinking score is 42.18 with an average critical criterion score of 64.20 and a standard deviation of 10.08. In Table 7. also obtained the value of variance for critical thinking ability of 100.17. Critical thinking ability score category after using the comic integrated student worksheets can be shown in Table 8.

Table 8. Distribution of Critical Thinking Ability of Implementation Class Students

	Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
42.18	2	8.0	8.0	8.0
55.50	2	8.0	8.0	16.0
57.72	4	16.0	16.0	32.0
64.38	6	24.0	24.0	56.0
66.60	4	16.0	16.0	72.0
68.82	1	4.0	4.0	76.0
71.04	2	8.0	8.0	84.0
73.26	2	8.0	8.0	92.0
84.36	2	8.0	8.0	100.0
Total	25	100.0	100.0	

The ability to think critically in the highest frequency is at the ability of 57.72-66.60 with a frequency of 14, for a range of 73.26-84.36 as many as 4 frequencies and the smallest frequency in the range of 42.18-57.72 has a frequency of 8.

The implementation of critical thinking tests requires a longer time in the modelling class which is 40 minutes while supposed to work on 12 questions is given 30 minutes. This happens because students are not yet accustomed to working on multiple choice questions with critical thinking orientation. During this time student only work on ordinary multiple choice questions at the cognitive level of memorizing and understanding. The distribution of the ability of students in the modelling class on average is in good category even though there are students who have critical thinking skills that are still lacking. This indicates that the comic integrated student worksheets along with the critical thinking test instruments developed are able to measure students' critical thinking skills.

The critical thinking test implementation in the implementation class also requires a longer time of 40 minutes, while supposed to work on 12 questions is given 30 minutes. This happens because students are not yet accustomed to working on multiple choice questions with critical thinking orientation. During this time student only works on ordinary multiple choice questions at the cognitive level of memorizing and understanding. The distribution of students' abilities in the implementation class shows that many students in this class have excellent thinking skills and there are no students with less critical thinking skills. This indicates that the comic integrated student worksheets along with the critical thinking test instruments developed are able to measure students' critical thinking skills.

Learning to use the comic concept on the students' worksheets correlates with students' critical thinking. Comics that can improve attitudes, increase productivity, creativity, and search for different ones based on research [15]. When students enjoy the lesson, students are more attentive in class. The known fact is that "an image is worth a thousand words." Even if the picture doesn't convey a complete concept, cartoons can still help in making learning fun [16].

4. Conclusion

The integrated comic student worksheets are suitable for use based on validation. This is evidenced by empirical evidence which shows that students' worksheets can show the distribution of students' critical thinking abilities in both modelling and implementation classes in various ability categories. The critical thinking test developed is suitable for use based on the results of expert velocity with the Aiken V category is very high despite the weak test reliability. Feasibility of the test is also evidenced by empirical evidence through the test phase of the test which shows the level of difficulty of all critical thinking questions included in the medium category. The results of this learning innovation can be used as an alternative for teachers in measuring students' critical thinking skills. Every student has a variety of critical thinking skills; the teacher can measure students' critical thinking skills while at the same time getting students to answer high-level questions using the critical thinking test that has been developed.

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