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Developing student worksheet of natural science for the eighth-grade junior high school students based on critical thinking skills

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Abstract. This research was aimed to develop a valid and practical Students' Worksheet of Natural Science for junior high school students based on critical thinking skills. The development model used in this research was the Rowntree development model consisting of three steps, namely planning, development, and evaluation. The evaluation step was the formative evaluation step by Tessmer consisted of five steps, namely self-evaluation, expert review, one-to-one evaluation, small-group evaluation, and field testing. However, the field testing step was not done because the research objectives were only focused on validity and practicality. The data had been collected using walkthrough and questionnaire techniques. The results showed that the developed product was in a highly valid category based on the score of expert validations. The validation score obtained from the language expert was 4.73, the score obtained from the design expert was 4.56, and the validation score of critical thinking skills was 4.56. At the one-to-one evaluation step, the product was declared as very practical, practical, and quite practical. At the small-group evaluation step, the product was declared very practical and practical. Thus, the developed product has been valid and practical.

Keywords: Critical Thinking Skills, Development, Student Worksheet

1. Introduction

The curriculum is in line with the purpose of education. Students should be trained to be critical, creative, communicative, and collaborative. The 21st-century skills cover the knowledge, critical and creative thinking, ways of learning (literacy and soft skills), and ways to learn with other (personal, social, and civic responsibilities) [1]. One way to improve students' skills is for teachers to use critical thinking skills-based learning media. Before they can use it, teachers need to develop critical thinking skills-based learning media first.

According to Ennis [2], critical thinking can be defined as sensible and reflective thinking that focuses on deciding what to believe or do. Critical thinking is also one of the high-level thinking abilities, referring to objectives and assessments resulting in interpretation, analysis, evaluation, and collection as well as explanations of considerations containing conceptual, methodological, or contextual evidence [3]. Learning media are a set of learning resources that enable students and teachers to conduct learning activities [4]. Susdarwati & Cari[5] states that the learning media consists of a syllabus, lesson plan, activity sheet, assessment sheet, student book, teacher handbook, and



learning media. The learning media ease the teachers to be structured without having to remember much. Atasoy in Taslidere [6] states that students' worksheets are teaching materials that can build their knowledge and can encourage students' participation in classroom learning activities.

This research was conducted by reinforcing the results of a questionnaire distributed to junior high school teachers and students. Based on the results of the initial study, many teachers did not know how to apply critical thinking skills into the learning media. Thus, the students' worksheet is based on the critical thinking skills needed to be done. A total of 90.3% of students agreed that natural science learning should be based on critical thinking skills. Many still consider physics learning to be a difficult and tedious lesson. Less interactive learning caused perception problems in physics learning. Therefore, teachers must develop learning media to improve students' learning outcomes and to practice critical thinking skills.

Student worksheet development research had been done a lot before. Yet, no one has developed student worksheet based critical thinking skills on pressure material and its application in daily life. In previous research, Marlina and Sriyanti[7] has developed teaching materials based on critical thinking skills on the pressure material and its application in daily life. The development of student worksheets on pressure material has been carried out by Kayfi [8] with authentic inquiry learning and student worksheet based on critical thinking skills by Putri and Djamas [9] on work and energy. Much of the research had been conducted using a variety of learning models to improve critical thinking skills. As has been done by Khasanah and Supardi [10] with the scientific approach and Herdiansyah [11] with a problem-based learning model.

Based on the description, the researcher intended to develop the Students' Worksheet of Natural Science based on critical thinking skills. To make this study more targeted and efficient, the researchers limited this development research to pressure material and its application in daily life.

2. Research Method

The research method used in this study was the research and development method. Rowntree's development model had been used as the development model. Rowntree model is one type of product-oriented model to produce a printed teaching material that consists of three steps, namely planning step, development step, and evaluation step. The planning step consists of two steps, namely the analysis of needs and the formulation of learning objectives. The development step covers the topic development, drafting, production of prototypes that will be used for learning. At the evaluation step, the researchers used Tessmer's formative evaluation model consisting of five steps: (1) self-evaluation; (2) expert review; (3) one-to-one evaluation; (4) small-group evaluation; and (5) field testing. In this study, the field testing was not carried out because the focus of this study was only the validity and practicality. The development model is displayed in Figure 1.

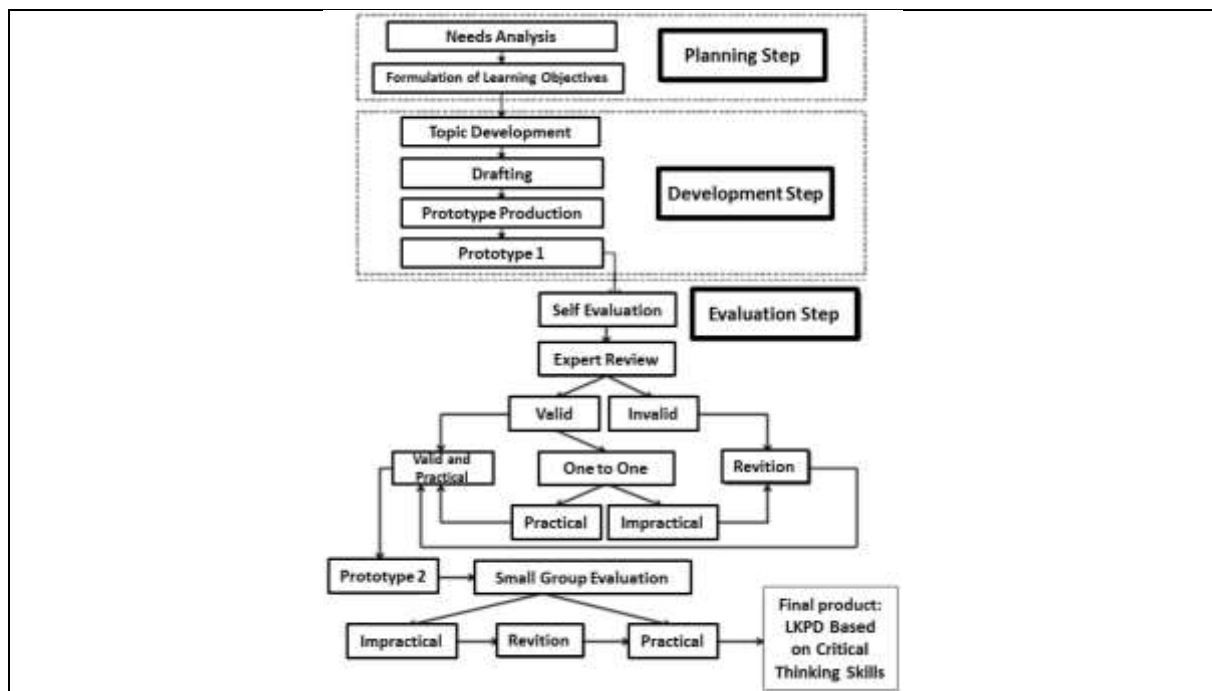


Figure 1. Development Steps (Rowntree Product Model and Tessmer Formative Evaluation)

This research was conducted in the first semester of the 2019/2020 academic year at a junior high school in Palembang. The study used walkthrough and questionnaire data collection techniques. The data collection instruments were validation sheets as the basis for revising the initial product or prototype 1. The questionnaire was filled by students to find out their responses and to obtain information on the practicalities. This questionnaire contained several statements with a score scale and suggestion columns.

The data that has been collected was processed to know the value through data analysis techniques. The data analysis techniques used were walkthrough and questionnaire data analysis. The expert validation questionnaire sheets were given to experts using Likert scales. The Likert scale was in the form of a checklist with five answer categories.

Table 1.Expert Validation Questionnaire

Category	Score
Excellent	5
Good	4
Quite Good	3
Bad	2
Poor	1

Source: Adapted from Sugiyono [12]

Table 2. The Validity Categories

Score Range (<i>i</i>)	Category
$\bar{X}_i > \bar{X}_i + 1,80 S_{bi}$	Very Valid
$\bar{X}_i + 0,60 S_{bi} < \bar{X}_i \leq \bar{X}_i + 1,80 S_{bi}$	Valid
$\bar{X}_i - 0,60 S_{bi} < \bar{X}_i \leq \bar{X}_i + 0,60 S_{bi}$	Quite Valid
$\bar{X}_i - 1,80 S_{bi} < \bar{X}_i \leq \bar{X}_i - 0,60 S_{bi}$	Less Valid

$$\bar{X} \leq \bar{X}_i - 1,80 S_{bi} \qquad \text{Invalid}$$

Source: Adapted from Purwanto [13]

Table 3. The Validity Categories of Student Worksheet Based Based on Expert Validation

Rata-rata Skor (\bar{X})	Category
$4,2 < \bar{X} \leq 5,0$	Very Valid
$3,4 < \bar{X} \leq 4,2$	Valid
$2,6 < \bar{X} \leq 3,4$	Quite Valid
$1,8 < \bar{X} \leq 2,6$	Less Valid
$1,0 < \bar{X} \leq 1,8$	Invalid

Source: Adapted from Widoyoko [14]

Students' responses toward the product at the one-to-one evaluation and small-group evaluation were taken through questionnaires. The scale used was the Likert scale. The questionnaire contained checklists of multiple statements as displayed in Table 4.

Table 4. Questionnaire Scores Using Likert Scale

Category	Score
SS (Strongly Agree)	5
S (Agree)	4
C (Quite Agree)	3
KS (Disagree)	2
STS (Strongly Disagree)	1

Source: Adapted from Sugiyono [12]

Table 5. Categories of Practicality Values

Range Score (i)	Category
$\bar{X} > \bar{X}_i + 1,80 S_{bi}$	Very Practical
$\bar{X}_i + 0,60 S_{bi} < \bar{X} \leq \bar{X}_i + 1,80 S_{bi}$	Practical
$\bar{X}_i - 0,60 S_{bi} < \bar{X} \leq \bar{X}_i + 0,60 S_{bi}$	Quite Practical
$\bar{X}_i - 1,80 S_{bi} < \bar{X} \leq \bar{X}_i - 0,60 S_{bi}$	Less Practical
$\bar{X} \leq \bar{X}_i - 1,80 S_{bi}$	Impractical

Source: Adapted from Purwanto [13]

Table 6. Student Worksheet Categories by Response

Average Score (\bar{X})	Category
$4,2 < \bar{X} \leq 5,0$	Very Practical
$3,4 < \bar{X} \leq 4,2$	Practical
$2,6 < \bar{X} \leq 3,4$	Quite Practical
$1,8 < \bar{X} \leq 2,6$	Less Practical
$1,0 < \bar{X} \leq 1,8$	Very Impractical

Source: Adapted from Widoyoko [14]

At this step, the suggestions and comments from students were written in the questionnaire sheet. The advice was to improve the product based on critical thinking skills so that it could be a more viable and easy-to-use product.

3. Results and Discussions

3.1 Planning Step

Analysis of learning needs had been carried out at the planning step as a first step starting in August 2019. Based on the results of the distributed questionnaire, not all schools in Palembang have implemented natural science learning in line with the 2013 Curriculum. The results of the questionnaire given to teachers show that (1) not all schools have implemented natural science learning following the curriculum 2013; (2) not all teachers have implemented learning based on curriculum 2013 by applying critical thinking skills to learning media; and (3) the students learning outcomes were unsatisfactory. The results of the questionnaire given to students show that (1) many students did not know critical thinking skills; (2) in the process of natural science learning, many teachers have not yet applied critical thinking skills to learning media; and (3) students agree that natural science learning should be based on critical thinking skills. Furthermore, syllabus analysis was conducted to determine the basic competencies of the core competencies based on the Regulation of the Minister of Education and Culture (Permendikbud). It was done so that the developed product could be in line with the curriculum.

3.2 Development Step

This step was started in August 2019 to September 2019. The developed topics were matched with the indicators and learning objectives that students must achieve. The next step was preparing the outline of the worksheet. Next, a draft had been compiled that contained the components to be written into the prototype. This step also covered the design and appearance. The initial prototype was called prototype 1 which was assessed based on the evaluation criteria.

3.3 Evaluation Step

This evaluation step aimed to find out the feasibility of prototype 1 was started in October 2019. In this study, the product is considered feasible if it has been declared valid by the expert and students. The results of each evaluation step were adapted into the formative evaluation model by Tessmer. The self-evaluation step examined the content of materials, language, and design to determine the accuracy and correctness of the products developed. After revising prototype 1, the product was declared eligible to continue at the expert review step.

The expert validation was conducted by three validators. The results can be seen in Table 7.

Table 7. Validation Assessment Results on STUDENT WORKSHEET Substance Pressure and Its Application in Daily Life

No	STUDENT WORKSHEET Validation	Score Recapitulation	Category
1	Content Validation	4,76	VERY VALID
2	Language Validation	4,73	VERY VALID
3	Design Validation	4,56	VERY VALID
4	Validation of Critical Thinking Skills	4,56	VERY VALID

Based on the data, it can be concluded that prototype 1 belonged to the very valid category. Furthermore, the one-to-one evaluation step aimed to look at the practicality of the product in terms of users and identifying and reducing overall errors. At this step, prototype 1 was tested to 3 classes which then followed by a questionnaire consisting of 13 indicators.

The indicators of student questionnaires consisted of (1) the clarity of the purpose of learning, (2) the information is easy to understand, (3) the material helps students to understand the concept, (4) the material is in line with the learning objectives, (5) it fosters the critical thinking skills of students, (6) it makes students more motivated to follow the learning, (7) the information can add insight to the

learners, (8) the font type used is easy to read, (9) the font size is easy to read, (10) the language is simple and easy to understand, (11) the combination of images, colors, and backgrounds are interesting, (12) the paper size and margins are precise so that it is easy to carry around, and (13) its design is consistent and eye-catching. The results of the assessment of students' response questionnaires can be found in Table 8.

Table 8. One-to-One Evaluation Assessment Results

INDICATOR	RESPONDENTS			AVERAGE SCORE	CATEGORY
	RP	RF	EHP		
1	4	4	5	4,33	Very Practical
2	5	4	4	4,33	Very Practical
3	5	5	3	4,33	Very Practical
4	4	3	2	3	Quite Practical
5	3	5	1	3	Quite Practical
6	4	4	2	3,33	Quite Practical
7	4	5	3	4	Practical
8	5	4	4	4,33	Very Practical
9	5	3	5	4,33	Very Practical
10	5	4	4	4,33	Very Practical
11	4	5	3	4	Practical
12	3	4	2	3	Quite Practical
13	4	3	1	2,67	Quite Practical

The table shows that the very practical indicators were numbers 1, 2, 3, 7, 8, 9, 10, and 11. The practical indicators were numbers 7 and 11. The quite practical indicators were numbers 4, 5, 6, 12, and 13. The fairly practical category indicated that some students did not feel the increase in their critical thinking skills and motivation during learning. Also, the margins were not precise and the design was still less attractive. Based on the results of revisions, prototype 2 had been produced and tested at the small-group evaluation step. At the small-group evaluation step, prototype 2 was tested to 9 ninth-grade students by giving the same questionnaire as the one-to-one evaluation step. The results of the small-group evaluation can be seen in Table 9.

Table 9. Small-Group Evaluation Assessment Results

INDICATOR	RESPONDENTS									AVERAGE SCORE	CATEGORY
	RM	NM	NS	MF	NL	A	AH	DF	MR		
1	4	4	4	4	4	4	4	4	4	4	Practical
2	5	5	5	5	5	5	4	5	4	4,78	Very Practical
3	5	5	5	4	4	5	4	4	5	4,56	Very Practical
4	4	4	4	5	5	5	5	4	4	4,44	Very Practical
5	3	3	3	4	3	5	3	5	5	3,78	Practical
6	3	3	3	5	4	5	3	4	4	3,78	Practical
7	5	5	5	4	5	5	4	5	4	4,67	Very Practical
8	4	4	4	5	4	5	3	4	4	4,11	Very Practical
9	4	4	4	4	4	5	3	4	4	4	Practical
10	4	4	4	5	4	4	4	4	5	4,22	Very Practical

INDICATOR	RESPONDENTS									AVERAGE SCORE	CATEGORY
	RM	NM	NS	MF	NL	A	AH	DF	MR		
11	4	4	5	4	4	4	5	5	4	4,33	Practical Very Practical
12	2	5	4	5	5	3	5	4	4	4,11	Practical
13	5	5	5	4	5	5	5	4	4	4,67	Very Practical

The table shows that the very practical category was found in indicators numbers 2, 3, 4, 7, 8, 10, 11, and 13. The practical categories were found on indicators number 1, 5, 6, 9, and 12. No indicators belonged to quite practical as found at the previous step. The product had been revised based on the advice of the students. Students felt the improvement of their critical thinking skills and motivation. Furthermore, comments and suggestions for small-group evaluation were used to revise prototype 2.

In line with the research of Sari, Sujarwanta, and Santoso [15], critical thinking worksheet requires students to learn critical thinking. A good action could be generated by critical thinking skills [16]. The advantage of the developed product is that the combination of text and images can increase attractiveness and can facilitate students' understanding, questions and learning activities can be more structured, and improve the critical thinking skills of students.

4. Conclusions and Suggestions

Based on the research, it can be concluded that the student worksheet of natural science for the eighth-grade junior high school students based on critical thinking skills has been declared very valid. At the one-to-one evaluation step, the student worksheet obtained average assessment results with the very practical indicators were numbers 1, 2, 3, 7, 8, 9, 10, and 11. The practical indicators were numbers 7 and 11. The quite practical indicators were numbers 4, 5, 6, 12, and 13. At the small-group evaluation step, the very practical category was found in indicators number 2, 3, 4, 7, 8, 10, 11, and 13. The practical categories were found on indicators number 1, 5, 6, 9, and 12. Several suggestions had been produced, namely the research should be continued to the field testing step to know its effectiveness.

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