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A SCIENCE LITERACY-ORIENTED STUDENT WORKSHEET DEVELOPMENT FOR JUNIOR HIGH SCHOOL ON THE TOPIC OF WAVES AND DISASTERS

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Abstract: This study aims to explain the process of developing student worksheets and determine the level of validity of the developed student worksheets. The method used in this study is research and development (R&D) with a 4-D development model following Thiagarajan. This study was conducted in 3 stages: define, design, and develop. The instrument used in this study was a validation sheet filled out by teaching experts and science practitioners. The validation results gained 84.73% in the very valid category. The validation results on aspects of content feasibility, linguistic aspects, presentation aspects, and visual aspects respectively obtained an average percentage of 86.25%, 85.42%, 82.16%, and 90.63%, with very valid categories. The worksheets can be used for school science learning activities with a few revisions.

Keywords: *Student Worksheet, Science Literacy, Wave and Disaster*.

INTRODUCTION

The growth of science and technology in the 21st century happens very unexpectedly, so it requires students to have many skills which can assist them in keeping up with the times. One of the most critical skills students should have is scientific literacy [1-4]. Not only confined to reading and understanding science, but scientific literacy is also someone's ability to apply science to solve troubles and make decisions based on empirical evidence, especially those relevant to careers and everyday life [5].

In Indonesia, the quality of education, especially science education, is still low because the scientific literacy skills of Indonesian students are still relatively low based on the assessment of the PISA, which is an organization initiated by the OECD. From PISA 2012 to 2018, Indonesia ranks in the bottom 10 OECD countries [6]. Therefore, it is crucial to improve students' scientific literacy so that improving the quality of education in Indonesia can be carried out and may compete with other countries. It is one of the reasons the Ministry of Education and Culture revised the Education Unit Level Curriculum (KTSP) in the 2013 Curriculum [7]. The development of the 2013 curriculum is oriented to increase and balance the competencies of attitude, skills, and knowledge. The 2013 curriculum, in general, has expectations that lead to realizing scientific literacy [8].

Based on interviews with teachers, science learning does not implement on an integrated basis. The practicum guide teaching materials used only contain brief material, practice questions, and experimental instructions. The learning method used by the teacher is in the form of a lecture method and tends to be teacher center, so the learning process is less effective because the role of students is passive. The achievement of basic competency-4 is often constrained because of the unavailability of practical guides that students can use independently. The response of students during practicum activities was quite good. However, they did not understand the concepts they were studying because they tended to memorize the subject matter without applying it. So many students memorize a concept that they did not understand; besides, the teacher understands scientific literacy only by reading many books and understanding the subject matter. Therefore, the teacher only trains literacy in reading skills. The scientific literacy ability of students was only limited to the aspect of understanding science content. They had not been able to apply scientific knowledge in solving problems during practicum and making decisions, so students' scientific literacy skills were still lacking.

Junior high school students are students aged 11-15 years. Judging from Piaget's cognitive theory, adolescent thinking has reached the stage of formal operational thought, the stage of cognitive development that begins at the age of 11 or 12 years and continues into adulthood [9]. A teenager can think abstractly, deductively, and inductively at this stage. At this stage, the child can predict something that may or will happen (hypothesis), look for answers, deal with problems more diversely, and think scientifically [9-10]. Based on this, students should be able to understand and work on PISA scientific literacy questions [11].

The scope of science material is not far from everyday life; which emphasizes real-life problems. For this reason, the planned learning must be accommodated and actualized through scientific experiment activities, which are one of the efforts to improve scientific literacy [12]. Science learning must be contextual and familiarize students with observing science objects to gain experience. A learning experience that shows the relationship of conceptual elements makes the learning process more active. The conceptual relationship studied with the

relevant science discipline aspect will form a cognitive schema so that students acquire the integrity of knowledge [13].

Basic competencies (KD) in this study are used to train and develop students' scientific literacy skills, identified and arranged systematically. The KD used to train scientific literacy skills in this study were KD 3.10 and KD 4.10 in grade VII, and KD 3.11 and KD 4.11 in grade VIII. The concepts of vibration and waves in class VIII and natural disasters in class VII can be presented in the theme of waves and disasters, which are one of the science concepts by scientific literacy. The material is abstract but concrete in everyday life, while the learning process at school only memorizes and answers questions, so the learning experience gained by students is not enough to train scientific literacy skills.

People remember as much as 90% when they simulate, model, design, or present and do something real. The more concrete students learn (direct experience), the more experience they get [14]. Waves and Disasters' theme can be learned by making disaster props and simulating how the disaster occurred. The learning experience gained by students becomes meaningful because the concepts taught are contextual. Good students' scientific literacy skills can be used to make decisions in their lives. The hope is that students can understand the causes of natural disasters and apply what steps should be taken if a disaster occurs.

Based on the problems which have been described, solutions are needed to overcome them. Science student worksheets oriented toward scientific literacy are one solution that can be used. Science literacy-oriented student worksheets is a worksheet that contains the stages of scientific literacy as outlined in activities. The use of scientific literacy-oriented student worksheets is expected to facilitate students' practice literacy through student worksheets to improve students' scientific literacy skills in aspects of context, competence, knowledge, and attitudes. Some of the characteristics of science literacy-oriented student worksheets are 1) student worksheets use a webbed type thematic model; 2) student worksheets are integrated with scientific literacy; 3) student worksheets are contextual.

Several studies have revealed that scientific literacy-based worksheets are suitable for use, make it easier for teachers to guide practicum, and effectively improve students' scientific literacy skills. Guided Inquiry-Based Student Worksheets are effective in pre-experimental research [15]. It could significantly improve students' scientific literacy skills in the knowledge aspect and competence based on the average value of the students' N-Gain acquisition of 0.56. Student worksheets based on scientific literacy on plant material developed with a 4-D model and data collection techniques used in student worksheet validation and tests obtained a score of 3.85 with a very valid category [16]. The worksheets developed were considered effective in improving students' scientific literacy because there was an increase in scores from pre-test to post-test. Guided inquiry-based student worksheets to improve junior high school students' scientific literacy skills obtained a result of 0.9 with very valid criteria. The student worksheet developed effectively improved students' scientific literacy skills [17]. Therefore, we are interested in studying the development of science literacy-oriented student worksheets for Junior High School on waves and disasters.

RESEARCH METHODS

The research was conducted in the Faculty of Teacher Training and Education of Sultan Ageng Tirtayasa University, Indonesia, in the 2020/2021 academic year. The research period starts from November 2020 to March 2022.

The subject of this development research is the party that validates the worksheet. Subjects were selected using a purposive sample technique because the researchers chose experts in the product field who have long experience in teaching and have a minimum educational history of undergraduate. The subjects are two science education lecturers who validated the developed worksheet at Sultan Ageng Tirtayasa University and two science teachers at a junior high school in Banten.

The method used in this research is Research and Development. Developing a science literacy worksheet oriented to scientific literacy uses a procedural model that adopts the 4-D model [18]. The procedural model is a descriptive model which outlines the steps that must be followed to produce a product.

This method and model were selected because this study aims to produce a product in the form of worksheet science-oriented to scientific literacy. The research design used in this study is a research design for developing a 4-D model developed by Thiagarajan (1994), which includes the define, design, develop, and disseminate stages [18].

The instruments used in this study are interview instruments and validation instruments. The data obtained from the interviews were processed descriptively. The validation instrument was given to the expert in a Likert scale with four categories, namely excellent, good, quite good, and not good, based on Table 1.

Table 1. Validation sheet scoring criteria

Mark	Number
Excellent (SB)	4
Good (B)	3
Fairly Good (CB)	2
Not Good (KB)	1

[19]

Validated data were processed using Microsoft Office Excel and then analyzed quantitatively and

described to simplify it into a form so that it is easier to read for conclusions to be drawn. The data processing uses the following equation:

$$\% \text{ percentage} = \frac{\Sigma \text{ earned score}}{\Sigma \text{ max. score}} \times 100\%$$

Interpretation of the value obtained in the form of a percentage; the distribution table of the assessment is determined by category based on Table 2 below:

Table 2. Validation value interpretation category

Average value	Category
81.25% - 100%	Very Valid
62.50 % - 81.24%	Valid
43.75% - 62.49%	Quite Valid
25% - 43.74%	Invalid

[20]

The worksheet can be valid and used in learning activities based on expert and practitioner validation results if, in each aspect of the validation sheet, the average percentage result is 62.50%.

RESULTS AND DISCUSSION

The initial design of the worksheet was made based on the data obtained regarding the curriculum, basic competencies (KD) on the wave and disaster theme, indicators, learning objectives, and the format for the preparation of the worksheet. The initial design started by compiling the worksheet using Microsoft Word 2016 and Microsoft PowerPoint 2016 with A4 paper size, using Century Gothic and Malgun Gothic font styles. Activities in the worksheet are arranged referring to the stages of science literacy learning and guided inquiry learning models combined with scientific literacy competencies. Based on the initial design that has been made, the structure of the worksheet developed follows what has been determined by the Ministry of National Education [21]. The structure of the worksheet developed includes a cover, introduction, instructions for use, table of contents, essential competencies, indicators, practicum objectives, activities, assignments or questions, glossary, and bibliography.

The next stage is to assess the worksheet developed with a validation instrument. Validation is carried out to know the advantages and disadvantages of the developed worksheet. Validation was carried out by a teaching material expert validator consisting of two science lecturers and a practitioner validator consisting of two science teachers. Aspects assessed by the validator include aspects of the feasibility of content, language, presentation, and graphics. After the validators validate the worksheet, revisions are made to improve the worksheet by the suggestions given by the validator. The average percentage obtained by each aspect of assessment based on expert and practitioner validation results is shown in Figure 1.

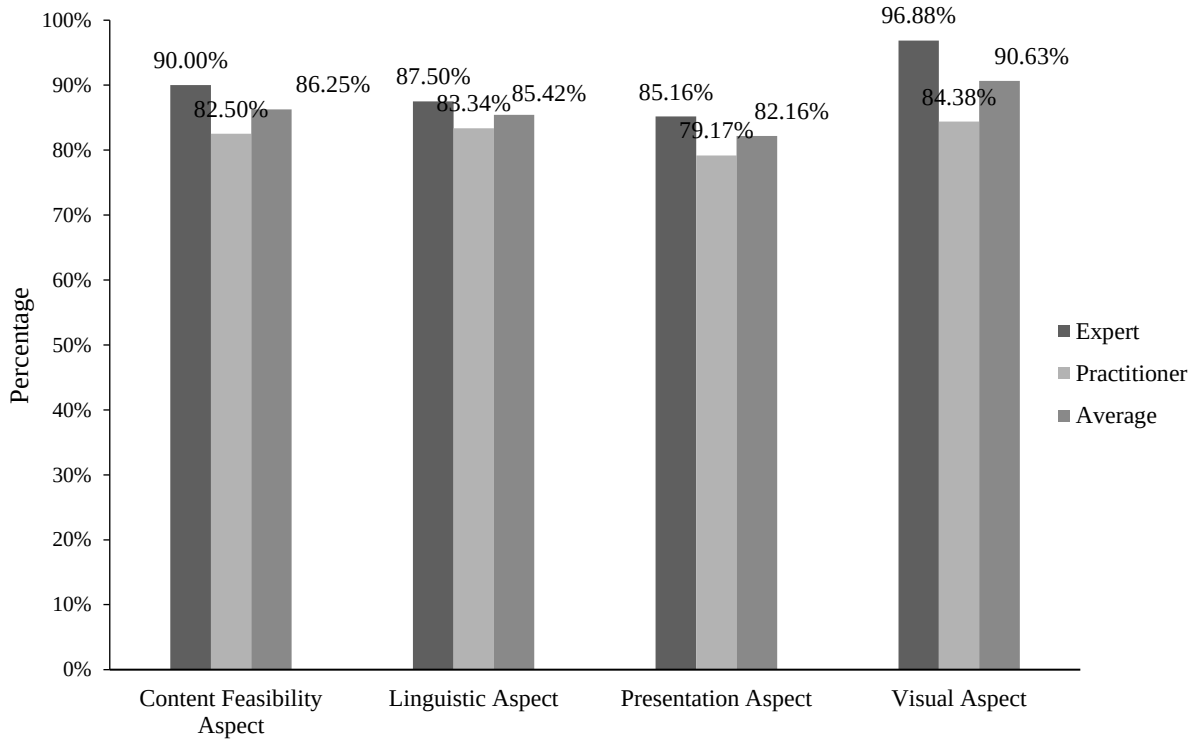

Figure 1. Percentage of Validation Results by Expert Validators and Practitioners

Figure 1 shows that the assessment of the validators and practitioners of teaching materials shows that the worksheets developed are in the very valid category. The overall value obtained is 86.11%. The feasibility aspects of content, language, presentation, and graphics each got 86.25%, 85.72%, 82.16%, and 90.63%, which is valid.

There are two indicators in the aspect of content feasibility, namely 1) Conformity of KI/KD and Wave and Disaster Themes; and 2) compatibility with the needs of students. The first indicator scores 86.46%, which shows the material in the worksheet developed by KD 3.10 and 4.10 in class VII and KD 3.11 and 4.11 in class VIII and indicators that students must achieve. The worksheet contains material on waves and disasters with topics such as seismic waves, the ring of fire, and natural disasters in Indonesia. The material presented in the worksheet is a collection of supporting information that contains an overview of the material being studied [22]. The content of teaching materials developed must be by KD and the development of students [21, 23]. Sientific literacy used in learning must be relevant to science learning materials in schools and conditions social students [24]. The second indicator scores 85.42%, which indicates the content of the material in the worksheet is by the needs of students. Scientific literacy emphasizes the problems of everyday life and the importance of scientific literacy skills for students to apply science as a consideration in solving problems in everyday life [12]. The worksheet developed is also related to the students' daily lives. The presentation of material on the worksheet includes material that explains waves and disasters and contains information about scientists' stories and relates the material to everyday phenomena such as the tsunami that hit the students' areas of origin. Students can better identify and explain their area of origin and the customs or culture in the area [25].

There are two assessment indicators on the linguistic aspect, namely 1) Language compatibility with the General Indonesian Spelling Guidelines (PUEBI); and 2) Use of language effectively and efficiently (clear and concise). The value obtained in indicator number two is the lowest value in this aspect, which is 84.38%. There are still some sentences in the questions that are relatively difficult to understand or unclear for students; for this reason, revisions will be made by simplifying sentences so that each task in the worksheet can be understood and completed correctly. The development of teaching materials with very valid and correct Indonesian rules and according to the development of students can make it easier for students to understand learning [26-28]. The criteria for a good worksheet are related to the ease of sentences, the relationship between sentences, sentence vocabulary, and sentence length.

The presentation aspect aims to assess the completeness of the worksheet and the suitability of learning activities with aspects of scientific literacy. Based on the validator's assessment in Figure 1, the presentation aspect got an average score of 82.16%, with a very valid category. In the presentation aspect, there are seven assessment indicators. the preparation of scientific literacy-oriented worksheet has clear learning objectives. The order of presentation is appropriate to the level of students, where the presentation of activities in the worksheet starts from simple things to more complex things [29].

The developed worksheet can motivate and attract students; an attractive worksheet appearance is the first factor in attracting students' learning interests. Suitable teaching materials must present anything that makes students interested in learning [30]-31]. The better student's interest in learning, the better the students understand the material [32]. The information presented in the worksheet is complete, starting from material regarding the geographical location of Indonesia, seismic waves, and old disasters that occurred in Indonesia. There is sufficient space for students to write answers to the discussion results in scientific literacy-oriented worksheets.

The developed worksheet plays a role in helping and encouraging students in learning activities to guide effective and efficient learning. worksheet is very influential on students' activities and learning outcomes because it makes students learn independently and makes it easier for them to understand the material scientifically [33-34]. The worksheet developed refers to the scientific literacy aspect, the competence aspect, which includes explaining scientific phenomena, designing scientific investigations, and interpreting data and evidence scientifically [12]. The worksheet developed pays attention to the active involvement of students in learning which is shown through group discussions [35]. The learning method contained in the worksheet is the experimental method which is one of the learner-centered methods to experiment both in groups and individually to understand science concepts [36]. In scientific literacy-oriented worksheets, experimental methods involve students in groups to carry out problem and hypothesis formulation activities, design tools and materials, design practical steps, test hypotheses (conduct experiments), and conclude experimental results. Students are directed to do every activity contained in the worksheet by the instructions when the learning process occurs. Activities in scientific literacy-oriented worksheet are stages of scientific literacy that are adapted to refer to the stages of the guided inquiry learning model. Teachers can use other learning models according to the stages of scientific literacy when carrying out classroom learning using this worksheet. The teaching and learning process with the guided inquiry model makes it easier for students to get the necessary instructions in the form of guiding questions [37]. Besides that, learning with the guided inquiry model can stimulate students' curiosity to provide solutions

to the problems given. Hopefully, students are interested in tin science issues and problems so that students become scientifically literate, that is, have a sense of responsibility towards the surrounding environment by applying scientific concepts that have been learned to solve problems in everyday life [15, 38].

From the results of the interviews, the characteristics of students do not like to read long texts; therefore, at the problem orientation stage, worksheet is presented using conversation to make it easier for students to identify problems. The problem orientation stage is the first stage in the worksheet; at this stage, students identify problems in the available text and images, then make hypotheses based on the problems they find. In the next stage, students in groups design experiments and make props for the tsunami disaster, after which students demonstrate in groups in front of the class. The results of the experiments that have been carried out are then written as answers to the available questions. Students are asked to conclude the experimental activities carried out in the final stage.

The worksheet development provides sufficient space for students to write or describe something on the worksheet. One of the requirements for worksheet construction must have sufficient space to give students the breadth to write or describe the things they want to convey [29].

There are four assessment indicators on the visual aspect, namely: 1) Use of letters (type and size); 2) Layout adjustment; 3) Addition of graphic illustrations, pictures, and photos; and 4) Adjustment of display design. Based on the validator's assessment results in Figure 1, the visual aspect obtained an average percentage of 90.63%, showing that the size and type of letters used in worksheet do not make it difficult for students or readers. The layout between text and images on the worksheet is orderly and proportional. The position between proportional writing and pictures and pictures that support the contents of the worksheet is essential because, in addition to clarifying, it can also increase the attractiveness of students to use the worksheet [39]. The use of pictures and illustrations in worksheet is compatible with the theme of waves and disasters. The right pictures and illustrations make it easier for students to capture ideas and information in the worksheet and increase students' understanding of learning the theme of waves and disasters [22, 40]. In addition, illustrations are needed in developing worksheet to increase students' attractiveness in studying worksheet [41]. The display design of worksheet can be attractive and compatible with the theme of waves and disasters, resulting in meaningful learning activities for both teachers and students [21].

CONCLUSION

The worksheet development is carried out using the Research and Development method, namely the 4-D development model developed by Thiagarajan which defines, design, develop, and disseminate. The 4-D research stage is modified into three steps: define, design, and develop. The results of the assessment of expert and practitioner validators related to the level of validity of teaching materials for worksheet science literacy oriented on the wave and disaster theme obtained a score of 84.73% in the "very valid" category based on four aspects of the assessment, namely aspects of content feasibility, linguistic aspects, presentation aspects, and visual aspects.

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