The Development of Student Worksheets Based On Scaffolding Learning Strategy

Atika Nurul Fathiyah[1], Mitri Irianti[2], Azizahwati[1], Yennita[1]
[1]Departement of Natural Science Education Universitas Riau [2] Departement of Physics Education Universitas Riau
atikafurusawa@gmail.com

Abstract- The purpose of this study was to elaborated the worksheets based on scaffolding with a 4D design (define, design, develop and disseminate). Data collection instruments used were the validation sheet given to 3 vaidators. Content feseability, presentation eligibility, language feseability, and graphic eligibility are the aspects which were assesed by the validator using Likert scale. Based on the data analysis, obtained that all aspects got an average score 3.47 on a scale of 4 and was categorized in very high category. The Worksheets can be said has a valid status. For the purpose of testing the effectiveness of the worksheets, a cognitive test was given to 60 students in grade XI of MAN 1 INHIL which consisted of 15 question items. The data analysis showed that there are differences in learning outcomes between students who are using worksheets based on scaffolding with students who do not. The learning outcomes of the students who were taught by using the worksheets were higher than the students who were taught by conventional model.

Keywords: Development; Student Worksheets; scaffolding

1. Introduction

Physics is one of the important subjects taught in schools for several reasons. First, in addition to the ability to provide knowledge, physics can help student to develop the ability to think, collaborate, communicate and find something scientifically which were useful to solve problems in daily life. Secondly, physics facilitates learners with the knowledge, understanding and skills needed if they want to continue to pursue higher education, especially in science and technology (Made in 2013). But in reality, physics is regarded as a difficult subject to understand, this is reinforced by the fact of low learning outcomes of the students. Based on interviews and obeservation conducted in some schools, the low achievment in learning outcomes were caused by the inability of students to find the main idea in solving physics problems if the question showed was different from the questions given during the learning proces.

In exploration process implemented by students, the role of teacher is as facilitator in giving scaffolding to students who find difficulty. Because in initial stage, students need support from more competent person to be able to reach ZPD (zone of proximal development). This scaffolding is intended as help or guidance from teacher in the initial of learning then giving opportunity to students to take over more responsibility after they can do it by themselves (Zulhelmi, 2017). Teacher's help is very needed to make them become more directed so the process of learning implementation and the achieved goal can be implemented well. This scaffolding is needed because actually students have rich potency but they had not possessed ability to organize information or initial ability. The ability to organize according to is known as one form of metacognition ability (Hepsi, et al., 2017).

According to Vygotsky (in Trianto 2010) that the concept of scaffolding should be given tasks that are complex, difficult and realistic, then given enough assistance to complete these tasks. However, students not taught piecemeal components of learning material, but were given a complex task until

one day, is expected to materialize into an ability to complete such complex tasks (Zulhelmi & Nor, 2019).

According Saye and Brush (2002), the scaffolding can be classified into two groups, soft and hard scaffold scaffold. Soft scaffolds refers to the teacher's behavior in response to the efforts of learners when learners need particular assistance. Examples of this type of scaffold is a tutor or facilitator of learning. Tutors play an important role to ensure that students learn and are satisfied with the troubleshooting steps provided. Tutors should be someone who is more knowladgeble and able to effectively facilitate groups of students. Other examples of soft scaffolding is the formation of colaborative study groups so that they can spread cognitive load and allows learners learn the complex domain. Zahra Chairani (2015) said that the characteristic of scaffolding learning strategies is the activity and the involvement of students in the learning process by utilizing the efforts of prior knowledge and learning styles of each student with the help of the teacher as a facilitator who helps students if students have difficulties in learning effort.

On the other hand, hard scaffolds are in general static supports that can be developed based on learner difficulties prior to an assigned task (Saye and Brush 2002). Such scaffolds can be provided once a task is assigned to the learner. Hard scaffolds can be in the form of computer or paper-based cognitive tools e.g. worksheets For example, one way of guiding instruction can refer to the use of scaffolds like process worksheets. Such worksheets provide hints or descriptions of the phases one should go through when solving the problem. Students can consult the process worksheet while they are working on the learning tasks and they may use it to monitor their progress throughout the problem-solving process (Rahmatya, et al., 2019). The worksheet itself is a collection of basic activities that must be carried out by learners weeks to maximize their understanding so they can develop basic competence in achieving the learning indicators. Worksheets learners should be in accordance with the basic competence (KD), motivating students and gain stundents interest to learn (Syabani, et al., 2018).

In this study, scaffolding used is specific to the assistance given to the questions in writing. Dawkins (2017) defines six common elements of how scaffolding can occur and further provide specific instances of each that are likely to be encountered in physics problems. Table 1 indicates item scaffolding elements in physics problems.

Table 1. The 6 elements of scaffolding with itemized examples of how each element is likely to appear in written physics problems.

No.	Scaffolding element	How do the elements appear in the issue of Physics
1	Use of representations and language to bridge expert-novice understanding	- Technical words described in everyday language - Mathematical symbols described in words - A diagram is used to interpret the technical words or symbols
2.	Reduction of cognitive overhead	- Includes a math (or other background) reminder - Somehow automates a routine task (e.g., unit conversions given, constants given that could have been looked up) - No penalty for missing sig figs, wrong unit, wrong numeric value, or other nonsalient component of the question - Provides a diagram or graph that the student could have constructed with the available information
3	Insertion of expert knowledge	- Expert directed focus is used (e.g., key information is highlighted using bold or italicized text) - Explicitly instructs student to make an expert assumption (e.g., “you may ignore air resistance”)

		- The student is warned of a common mistake or relevant misconception
4	Ordered task decomposition (provide structure for complex tasks)	- Each part of the question contains only one expected output (numeric or otherwise) - An output (numeric or otherwise) is required in subsequent work - Marks are awarded for interpreting outputs (no further calculation required) - Question has a wide mark distribution (each part is worth less than 50% of the total awarded marks)
5	Conceptual prompting	- Asks student to define or explain an equation that they should use - Asks student asks student to draw a diagram before beginning the problem to identify a concept that they should make use of - Ask students to draw a diagram before starting to solving problems
6	Reduction the degrees of freedom	- Gives student the appropriate equation to use - Prompts at how the question is expected to be solved (e.g., "using the principle of conversation of energy …") - Explicitly instructs student on how to begin a task

Combination of student worksheet and scaffolding strategy which stimulate learners to think by giving a number of guidance and provide the necessary assistance to the particular material. It will facilitate the students to understand the concept of the material being studied, because the scaffolding was a relief to learners which are structured in initial learning and then finally activate students to learn independently so as to make the students more understand the subject matter (Budaeng et al., 2017)

In general, the use of scaffolding and application of student worksheet have shown varying results in the achievement of learners. As an example, student worksheet based on scaffolding can improve critical thinking skills of learners. (Setyarini, et al., 2017). The development of scaffolding-based module for teachers and learners got very valid criteria (Budaeng et al., 2017). Meanwhile, according Serene (2011) the development and application of scaffolding worksheet based on PBL learning showed no significant effect on the students ability in learning.

2. Methodology

This study is a research and development study throught 4-D models. This model consists of four phases; define, design, develop and disseminate. Data collection in student worksheets devlopment was done by using questionnaires and test methods. Questionnaire method used to obtain the assessment of the validator by validation sheet. Content feseability, presentation eligibility, language feseability, and graphic eligibility are the aspects which were assesed by the validator using Likert scale. Category of Likert scale were stated in Table 1.

Table 1, Category On Every Aspects of Validation Sheet

No.	Category	Score
1	Strongly agree	4
2	Agree	3
3	Less Agree	2
4	Strongly Disagree	1

As for the validity of the categories were listed in Table 2

Table 2. Category of Validity

No.	Average Score	Category
1	$3{,}25 \leq x \leq 4$	Very high
2	$2{,}5 \leq x < 3.25$	High
3	$1{,}75 \leq x < 2.5$	Low
4	$1 \leq x < 1.75$	Very low

Each item of assessment indicators was considered valid if the range of the average score was in the high and very high category. If there is one of the assessment indicators are in lo and very low category,then the indicator should be improved.

The test method are used to obtain information on the effectiveness of the use of worksheets for students in the school. Cognitive tests on material sound and light waves was given to 60 students. The data then compared between the control group and the experimental class to determine whether the student worksheets that have been developed effective to improve the learning outcomes of the students.

3. Result and Discussion

Before conducting the study, researchers have to make preparations regarding to the implementation of the research by conducting interviews and observations to identify problems early through interviews with teachers of hysics. The result was found that student's academic ability is still low, as indicated by the low learning outcomes in previous KD. In addition, the knowledge that students already have previously were not used to build new knowledge, and not directed them toward the material whice are requiring the creativity of the students. It also be found that the participation of learners in the learning process is still low, and the lacking of media used in learning physics closure the ability of the student to reach the high achievement in learning.

After analyzing in the definition phase, then learning instruments were arranged at the design stage such as syllabus, lesson plans, student worksheets based on scaffolding, teacher and student observation sheet, and the competency test instument. To achieve a good learning instrumenst design, then Focus Group Discussion (FGD) was done with lecturers to maintain a scientific attitude and originality perspective of the isnruments that were developed,The material chosen was sound and light waves which were carried out within 12 hours of lessons. The student worksheets were designed for 3 events. Worksheets 1 discussed the characteristics of sound waves and Doppler effect, Worksheets 2

discussed the phenomenon of the strings and pipe organ, the sound intensity and the principle of sound waves, Worksheets 3 discussed the nature of light, diffraction, interference and polarization of light.

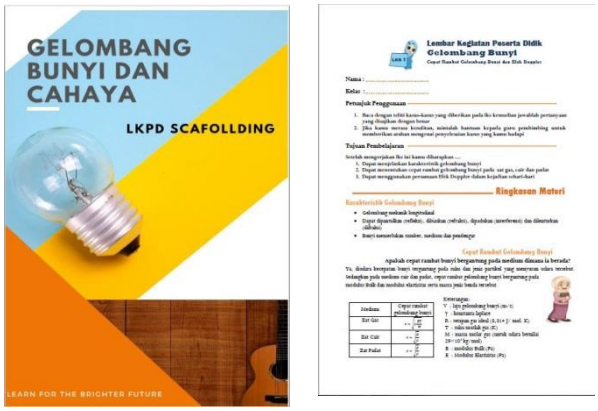

Figure 1. Design of student worksheet

After design was done, the next step in this research was the validation of the product. In the first validation, validator gives many suggestions for improvements. Suggestions from this validator were applied to repair scaffolding' worksheet. All the suggestions for improvement from validators were summarized in Table 3 below.

Table 3, Suggestions for worksheet improvement from validator

No.	Suggestion
1.	Scaffolding were not found in the worksheet and lesson plan.
2.	Replace the term LKS to LKPD,and term siswa to peserta didik.
3.	Pictures and illustrations provided should be helpful in order to gain conceptual understanding.
4.	Use language that directed the learner to understand the concept well.
5.	Do not provide formula and material in the worksheet.
6.	If there is no trial activity, provided the process skill activities by giving tables or graphs.
7.	Put unit in the observation table
8.	The instructions given should be more detailed.
9.	The activities in the worksheet should adjust to the objectives of the activity, not the learning objectives.
10.	The writing space should be adjusted.
11.	Give more contextual example.

The result of improvements then handed back to the validator to be revalidated. After being checked, the validator pass judgment on the validation sheet consisting of graphics and presentation aspects, language and content. The assesment on the graphics and presentation aspects related to the display, text and illustrations as well as the language used is summarized in Table 4.

Table 4. The results of the validation LKPD

No.	aspects Validation	Mean	Category	Conclusion
1	Graphics and presentation	3.53	Very high	Valid
2	Language	3.56	Very high	Valid

Table 4 shows the results of the validation LKPD on graphics and presentation aspects, as well as the language got a score of the mean average 3.54, This means that the student worksheets that have been

developed have an attractive design, well written and easy to read and comes with illustrative drawings in accordance with the concepts being taught. Appealing Aspect of the worksheets have fit the quality to enhance students interest in learning. In accordance with the study results by Muzari (2015) which stated that the appearance of an attractive modules can reduce boredom for students to learn.

The results of the validation on the content aspect were stated in Table 5.

Table 5, Worksheets Validation Results on The Content Aspect

No.	Aspects of Validation	Mean	Category	Conclusion
1	Material suitability with the syllabus of Kurikulum 2013	4.00	Very high	Valid
2	The depth of the material in accordance with learners level of thinking	3.00	High	Valid
3	Encourage learners to conclude the concept of law or fact	3.33	Very high	Valid
4	Encourage learners to focus on the problem by emphasizing the important concept that should exist	3.33	Very high	Valid
5	Encouraging learners on the precision of the concept (conceptual prompting)	3.33	Very high	Valid
6	Encourage learners to reduce the degrees of freedom by explicitly instructed how to begin a task	3.33	Very high	Valid
7	Concept arrangement	3.67	Very high	Valid
8	Conceptual relation with daily life	3.33	Very high	Valid
9	Workshees activities stimulate the curiosity of learners	3.33	Very high	Valid

After the worksheets have been declared as valid, the worksheets then applied to students during learning process. In order to determine its effectiveness in improving learning outcomes, competency test evaluation was given to the students. Anderson and Krathwohl (2010) defines evaluation a giving assesment based on criteria and standards to the examination and criticism. At the cognitive level, learners can express and defend opinions. Assessment task requires learners to consider the quality, credibility, and the practicalities of using established criteria and explain whether these criteria are eligible or not. Based on Bloom's taxonomy highest level in the cognitive domain is the ability to provide an assessment of a condition,

Learning outcomes of students who use scaffolding's worksheets in learning were higher than students who do not use scaffolding's worksheets. The result can be seen in Figure 2,

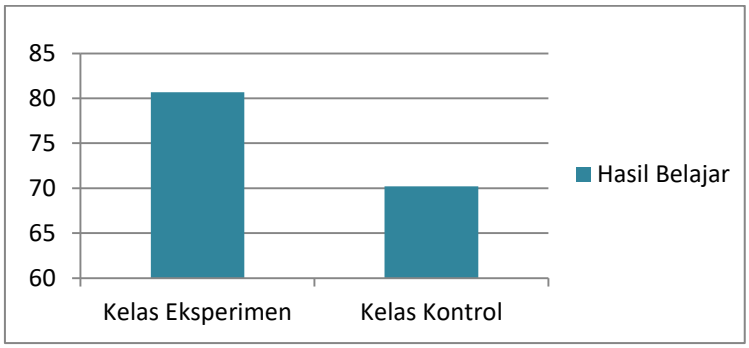

Figure 2. The Mean Value of Students' Learning Outcomes After Being Treated

From Figure 1, the mean value of students in the experimental class that uses woksheets based on scaffolding showed better results than the control class that uses conventional learning. Based on these data we can conclude that learning by using scaffolding's worksheets can effectively improve the learning outcomes of students. This was in line with Yildirum et.al (2011) which stated that the used of student worksheets was proved to be more effective compared to convetional learning method. Students can participate actively to understand abstract concepts and apply the concepts more effectively and permanently. Celikler and Hisar (2012) in they study also stated that worksheet ware useful to increase the motivation of learners to be interested and actively participating in the classroom.

4. Conclusion

Based on the results of the study, data analysis and discussion, it can concluded that the student workseehts based on scaffolding development has gone through the process and declared as valid content and construct validation. The aplication of this worksheets was already proved can enhance learning outcomes of students.

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