

The Development of Worksheets and Electronic Learning Materials Based on Project Based Learning on the Subjects of Physics

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Abstract—This study aimed to develop valid, practical and effective physics worksheets and electronic learning materials based on project based learning in grade XI students in wave subject. The type of this research was research and development (R&D) with 4D development model developed by Thiagarajan, et.al. This research was conducted at SMAN 1 Samarinda with 33 grade XI students of science class. The data in this research were collected using questionnaires of students' responses, expert assessment sheets, project appraisal sheets and tests to determine students' learning outcomes. Based on the result of the expert's assessment for worksheets and electronic learning materials can be concluded that the initial product was valid. Moreover, based on the result of paired T-test analysis between post-test and pre-test showed an increase in student learning outcomes and N-Gain score showed that the improvement was categorized as high. Also, the percentage of students' responses for worksheets and electronic learning materials showed the positive responses from students. In summary, the worksheets and electronic learning materials that have been developed were valid, effective and practical to use.

Keywords—Worksheet; Electronic Learning Materials; Project Based Learning

I. INTRODUCTION

In the 21st century, Science and Technology developed very rapidly in all areas of human life, both social, educational, health and other fields. To be survive in the 21st century, every individual is required to have the 21st century competencies (knowledge and skills) for participation, achievement and competitiveness in the global world. The several of 21st century competences were divided into 3 domains that is cognitive domain (thinking skill, knowledge and creativity), intrapersonal domain and interpersonal domain. Example competences for cognitive domain are high comprehension competence, critical thinking, creative thinking and innovativeness, problem solving, technological literacy, etc. Example competences for intrapersonal domain are self-regulation, metacognition, grit, flexibility, etc. Example competences for interpersonal domain are collaborate and communicate, conflict resolution, leadership and imitativeness [5],[10],[13],[17],[26].

The law No. 20/2003 Article 3 states "National education functions to develop the ability and form the character and civilization of a dignified nation in order to educate the nation's

life, aims to the development of potential learners to be a human being who believes and cautious to God Almighty, noble, healthy, knowledgeable, capable, creative, independent, and become a democratic and responsible citizen" [24].

Based on the results of a survey conducted by the Organization for Economic Cooperation and Development (OECD) in 2015 on the ranking and achievement of the Program for International Student Assessment (PISA), Indonesia ranked 64th in terms of science achievement from 72 participating countries. This showed that the quality of human resources, especially in terms of learning achievement is still low [11],[15].

The level of student learning achievement cannot be separated from the role of educators in this case is the teacher. Basically the role of a teacher is as a facilitator, mentor, environmental provider, model, motivator, cognitive development agent, and as a class manager [23]. As a class manager a teacher must be able to choose approaches, methods, and learning models that can create an active, innovative, creative, effective, fun, and engaging learning environment, as well as centered on the learner. So that, learners have a memorable learning experience. In addition, a teacher must also be able to develop learning materials and learning device that can support the learning process.

One of the learning models that can improve the learning experience of students is project based learning, because the project based learning model can improve the quality of teaching and learning in the classroom. In addition, project based learning also contributes to improving students' problem-solving skills, high-level thinking skills, creative thinking skills and collaboration and communication skills [14],[18].

II. LITERATURE REVIEW

A. Research and Development (R&D)

Research and development is a research approach that used to produce a new product or improve or develop an existing product, and validate the product to obtain a feasible product that is valid, practical and effective [3],[21],[22].

"Educational Research and development (R&D) is a process used to develop and validate educational products. The

steps of this process are usually referred to as the R&D cycle, which consists of studying research findings pertinent to the product to be developed, developing the products based on these findings, field testing it in the setting where it will be used eventually, and revising it to correct the deficiencies found in the field-testing stage” [4].

B. Worksheets

The worksheets is a printed material in the form of sheets of paper containing a summary of the material and tasks that must be done by the students and refers to the basic competencies to be achieved [6],[9].

C. Electronic Learning Materials

The learning materials are all kinds of materials in the form of material that has been prepared in a complete and systematic to help teachers in delivering lesson material and enable students to learn, so that the process of teaching and learning activities can take place properly, effectively, efficiently and smoothly [6],[20]. Electronic learning materials are learning materials whose content is loaded in electronic form. Learning materials that belong to electronic learning materials are e-books, e-magazines, e-news, e-journals, e-learning, and others [19].

D. Project Based Learning (PjBL)

Project based learning is a learning model that is oriented to the learning activities of students or student oriented, so that students can move freely in developing their creativity, ability and skills to be able to do a project through a series of activities: planning, practices and produce the final product [1],[2],[12],[16]. Project based learning is a model for classroom activity that shifts away from the usual classroom practices of short, isolated, teacher-centered lessons. In addition, PjBL learning activities are long-term, interdisciplinary, student-centered, and integrated with real-world issues and practices [8], Fig. 1.

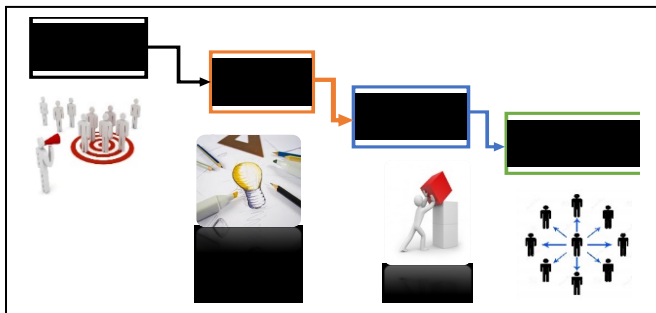


Fig. 1. 4D Development Model

Moreover, project based learning is such a modern teaching method. The core idea of PjBL is to connect student’s experiences with school life and to provoke can leverage the advantage of modern teaching techniques [7].

III. METHODOLOGY

A. Development Model

The development model used in this research is 4D development model that developed by Thiagarajan, S., Semmel, D., and Semmel M.I. (1974) consisting of 4 stages of Define, Design, Develop and Dissemination (see Fig. 1) [25].

B. Subject

Subjects in this study were selected using random sampling technique.

1) Pilot Study

Subjects in pilot study were students of class XI IPA 1 SMA Katolik WR. Soepratman Samarinda which amounted to 20 students.

2) Implementation Study

Subjects in this study were students of class XI MIPA 2 SMA Negeri 1 Samarinda which amounted to 33 students. All subjects have no experience in physics science teaching using project based learning approach.

3) Place and Time of Study

The study was conducted in SMA Negeri 1 Samarinda on April 17, 2017 until May 04, 2017.

C. Data Analysis Technique

The data was collected using expert assessment sheets, questionnaires of student response, project appraisal sheets and tests. Expert assessment results of developed products are used to assess the validity of the product. Expert analysis is calculated using equation (1).

$$RTP = (\sum_{j=1} A_j) / n \tag{1}$$

Where RTP means average of all aspect score, A_j is average score of each aspect and n is number of aspect.

In order to calculate the percentage of student responses using equation (2).

$$RS = (f/n)*100\% \tag{2}$$

Where RS means percentage of student responses, f is score total and n is score maximum.

The learning outcome, preliminary and final test results will be tested statistically. Statistical test conducted in the form descriptive statistic, paired t-test and N-gain score. The paired t-test conducted using SPSS 23 application and N-gain score calculated using equation:

$$\langle g \rangle = [(Post\ Test - Pre\ Test) / (Score\ Max. - Pre\ Test)] \tag{3}$$

IV. FINDINGS AND DISCUSSION

A. Description of the process of developing worksheets and electronic learning materials

As explained earlier, the development model used in this research is the 4D development model (Define, Design, Develop and Dissemination). In the define stage, there are 5 main steps that is front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives. In the design stage, there are 4 basic steps that is constructing criterion-referenced tests, media selection, format selection and initial design. In the develop stage, there are 2 main steps that is expert appraisal and developmental testing. In the dissemination, there are 3 basic steps that is validation testing, packaging, diffusion and adoption. But this research is only up to the validation testing stage [25].

B. Expert assessment results against worksheets and electronic learning materials

The level of validity of worksheets and electronic learning materials based on project-based learning is obtained from the analysis of the assessment of matter experts and media experts. The average of total assessment of all evaluators is then matched against the criteria of validity.

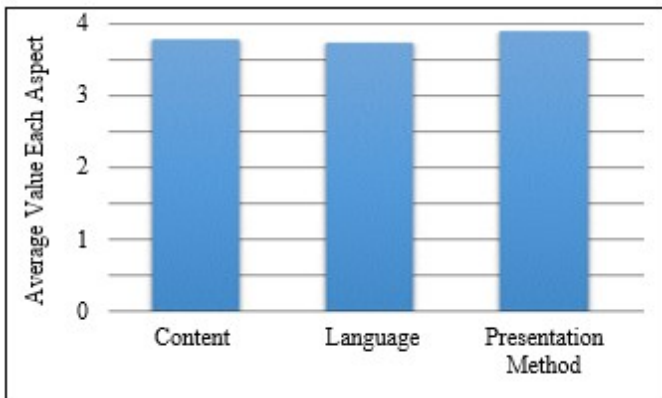


Fig. 2. Graph of Matter Expert Assessment for Electronic Learning Materials

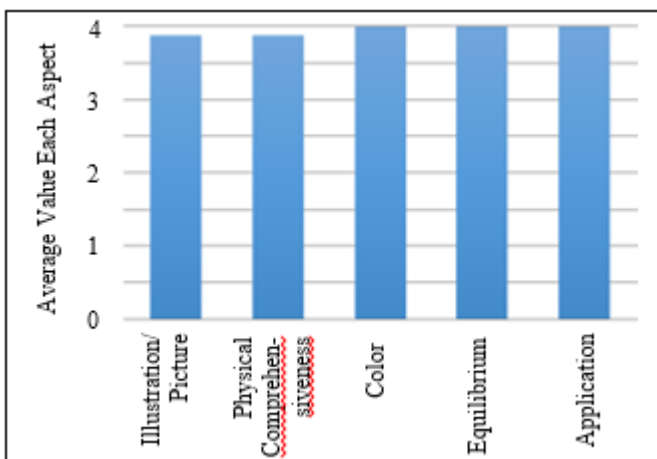


Fig. 3. Graph of Media Expert Assessment for Electronic Learning Materials

Based on Fig. 2 and Fig. 3 Average of matter expert assessment for electronic learning materials are in the range 3.5 - 4 (scale 1 - 4). By using the equation (1) obtained the average score of the result of matter expert judgment was 3.81 (scale 1 - 4) and the average score of the media expert was 3.95 (scale 1 - 4). Based on these two assessment results, it can be concluded the electronic learning material that have been developed was valid to be used as a learning material.

Based on Fig. 4 obtained the average assessment of matter experts, media experts and practitioners for worksheets are in the range 3 - 4 (scale 1 - 4). Thus, it can be concluded that the worksheet that have been developed was valid to be used as a learning device.

Based on the results of the assessment by the experts on the worksheets and electronic learning materials, then conducted a limited trial of worksheets and electronic learning materials was developed. The limited trials were conducted at SMA Katolik WR Soepratman Samarinda in grade XI IPA 2 and the results showed that the worksheets and electronic learning materials developed were feasible to be implemented with some improvements.

C. Analysis of learning outcomes

Based on Table I it can be seen that the average pre-test value is 31.14 with a standard deviation of 10.03, as well as the minimum and maximum values were 0.00 and 58.33 respectively. In addition, the average post-test score is 81.06 with a standard deviation of 10.73, as well as the minimum and maximum values were 60.71 and 92.86 respectively. Based on paired T-test between post-test and pre-test obtained, value $t_{calculate} > t_{table}$ (see Table II). It means that there was significant improvements in learning outcomes before and after learning using worksheets and electronic learning materials based on project based learning that have been developed.

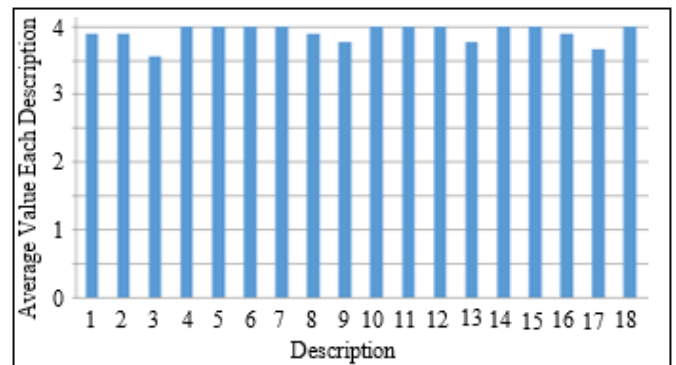


Fig. 4. Graph of Matter Expert, Media Expert and Practitiones Assessment for Worksheets

TABLE I. PRE-TEST AND POST-TEST VALUE

Type Of Test	Score		SD	Mean	
	Min	Max		Score	N-gain
Pre-Test	0,00	58,33	10,03	31,14	0.7181379
Post-Test	60,71	92,86	10,73	81,06	

TABLE II. THE PAIRED T-TEST RESULTS BETWEEN POST-TEST AND PRETEST WITH SPSS 23 APPLICATION

	Paired Differences				T	df
	M	SD	95% Confidence Interval of the Difference			
			Low	Upper		
Posttest-Pretest	49,92	15,25	44,51	55,32	18,803	32

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The result of N-gain value between the pre-test and post-test values obtained a value of 0.7181379. This shows that the improvement of learning outcomes of students of grade XI MIPA 2 SMA Negeri 1 Samarinda is categorized as high.

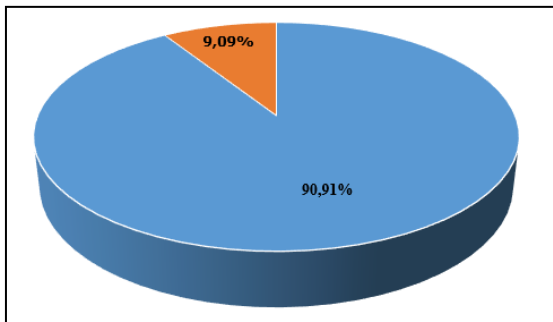


Fig. 5. Graph of Learning Outcome Percentage

Based on Fig. 5, it can be seen that the number of students who complete after following the learning process was 30 students (90.91%) of 33 students. Students were categorized as passed complete if they have minimum score 75 or more (value ≥ 75).

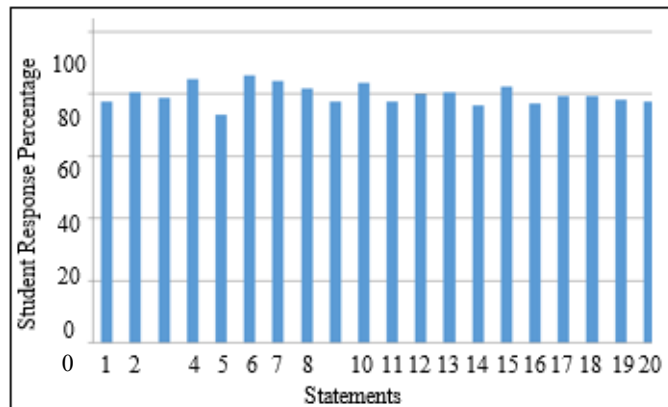


Fig. 6. Graph of Student's Response for Electronic Learning Materials.

This suggests that the worksheets and electronic learning materials that have been developed are effective in improving student learning outcomes.

D. Analysis of student response results

Based on Fig. 6 can be seen that the percentage of students' response to electronic learning materials based on project-based learning was in the range of 70% to 85%. By using the equation (2) obtained the average percentage of students' response to electronic learning materials was 79.85%. As well as the percentage of students' responses to the worksheets based on project based learning that have been developed was in the range of 65% to 83%. By using the equation (2) obtained the average percentage of students' response to worksheets was 79.11%. This indicates that the responses given by learners to the worksheet and electronic learning materials based on project based learning are positive, Fig. 7.

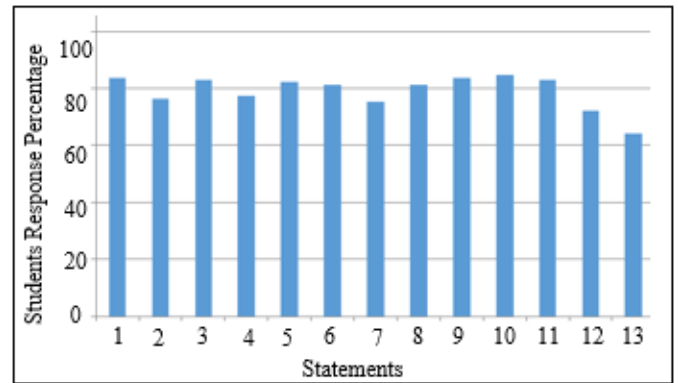


Fig. 7. Graph of Student's Response for Worksheets.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the results, it can be concluded that the worksheets and electronic learning materials based on project based learning that have been developed is valid, practical and effective to be used as learning device and learning materials in teaching and learning activities in class. Worksheets and electronic learning materials based on project based learning that have been developed can to improve learning outcomes and creativity of learners. This is in line with the research conducted by Yulianti that the use of worksheets based on project based learning on the subjects of physics grade XI in SMA 1 Sleman with the subject matter of fluid can improve the creativity of science learners [27] and research conducted by Assalma, Rahayu and Iswari that is worksheet developed with project based learning and insightful approach salingtemas is valid to be applied as teaching materials at SMAN 1 Nawangan and effective in improving learning outcomes, learning activities, and creativity of learners [3].

A teacher should be able to develop teaching materials and learning devices, in order to create an atmosphere where learners can learn. For further development research, teachers can use other learning models, so that teachers' creativity can increase.

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