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Development of Student Woorksheet Base on STEAM-PjBL Integrated on Reaction Rate Material for Senior high School Class XI

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ABSTRACT

This development research has produced teaching materials in the form of student worksheets (LKPD) integrated with STEAM-PjBL (*Science, Technology, Engineering, Art* and *Mathematics - Project Based Learning*) on the subject of Reaction Rate. The results of developing teaching materials that have been designed are tested for validity and practicality to fulfill the requirements of a LKPD. This LKPD development research uses the R&D (*Research and Development*) method namely research and development, with the 4- *D* model. This 4- *D model* has stages consisting of (1) *define,* (2) *design,* (3) *develop* and (4) *disseminate stages.* This development stage is only carried out until the *develop stage.* In this study using an instrument in the form of a validation questionnaire consisting of a content and construct validation questionnaire and a practicality questionnaire. Validation was carried out by validators, which came from 3 chemistry lecturers at FMIPA UNP and 2 high school chemistry teachers. Practicality testing was carried out by 2 high school chemistry teachers and class XI students from SMAN 13 Padang. Testing this LKPD will produce data that will be analyzed using the Aiken's *V formula.* Based on the results of the analysis it can be summarized that the resulting LKPD is a teaching material product that is categorized as valid based on a *V value* of 0.86.

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1. Introduction

21st century skills are a requirement to have 4 C skills Creativity, Critical, Thinking, Communication and Collaboration) for today's students [1] . These skills are acquired by students in the learning process, teachers as educators have a role in forming 21st century skills. One of the teaching materials needed in the learning process is LKPD. LKPD as an alternative teaching material and also able to train students' critical thinking skills [2] . These skills are also formed in the learning process which requires the right learning approach, one of which is STEAM which can be applied.

This STEAM approach is a provision and one of the reforms and innovations. With STEAM educators can strengthen the learning process to have critical thinking, generate creative ideas and work collaboratively using the application of learning based on problems or based on making a project [3]. Students in this STEAM approach can develop creativity as a means of cultivating problem-solving skills in real life [4].

STEM by adding Art to STEAM is an awareness of the needs of the 21st century generation who have new thinking skills so as to produce a creative and innovative generation, Art is added to become STEAM [5]. Likewise according to (Maeda, 2013) what can change the economy after science and technology is design and art [6].

STEAM is a learning approach that equips students with knowledge of science and humanities while developing 21st century skills namely critical thinking, communication, leadership, resilience and creativity [7]. Combining two or more aspects of disciplines in schools allows efforts to increase student learning [8].

The learning model based on project creation is an alternative that can be collaborated with an approach in which the five fields of study are related, namely the STEAM approach. Learning using the PjBL model , students are guided to design a project as a foundation and learning process where the end result of this learning is a product/project. Learning with this Project Based Learning model requires development for teachers and students in accordance with content standards in the curriculum and requires students to be able to bridge the subject matter with other subject matter by seeking information, evaluating, interpreting and synthesizing using meaning [9] .

The advantage of this project-based learning is that there is an increase for students in terms of learning motivation based on this model methodology [10]. In terms of learning outcomes, it was also found by other researchers that the Project Based Learning model led to an increase in learning outcomes for students [11].

Based on the analysis by other researchers of the development of the STEAM-PjBL LKPD it is said to be capable of training scientific thinking and daring to appear for arguments and can be used as an alternative to overcome students' basic thinking towards scientific and argumentative activities [12].

The field of study of chemistry is a field with learning that has an abstract nature. Reaction rate material is a discussion that is included in the field of chemistry studies. This material studies

the structure and changes in a material with a planned experiment [13]. So an approach and a model are needed that students can realize the concept of learning in this reaction rate material.

Based on observations that have been made in three schools namely SMAN 2 Padang, SMAN 10 Padang, SMAN 13 Padang. Based on the observations that have been made, it is obtained that the result data has been concluded, namely 65.39% of students are not interested in the Reaction Rate material. Based on the provision of a questionnaire on the level of understanding of the Reaction Rate material by students at SMA N 2, the results obtained a higher percentage of less understanding of the statement points of the Reaction Rate material, namely 71.8%, followed by SMA N 13 of 65.2% and SMA N 10 is 25.7%. Based on observations and interviews it was also found that the use of teaching materials in the form of textbooks, power points was being used, and one was using worksheets but still in a simple and colorless form. Of the three schools, they are still in a state where they have not designed and used teaching materials in the form of STEAM-PjBL integrated worksheets and practicum implementation of Reaction Rate material.

In learning chemistry, it must be able to increase students' interest and interest in chemistry lessons [14].

Based on the explanation above, the authors are interested in developing LKPD on the material Reaction Rate which is integrated with STEAM-PjBL. So that research will be carried out entitled "Development of STEAM-PjBL integrated LKPD on Reaction Rate Material for SMA"

2.   Experimental

The goal that forms the basis for research using the Research and Development (R&D) method, namely development research with the 4- D model, is that it is hoped that researchers will be able to produce STEAM-PjBL integrated worksheets on Reaction Rate material. 4- D as a research model used has four stages 4D [15]. This research only reached the develop stage, the disseminate stage was not carried out. Three lecturers from the chemistry department, FMIPA-UNP (Faculty of Mathematics and Natural Sciences, Padang State University) and two teachers from the chemistry department at SMA were the subjects of this development research.

1.   Define stage

The Define stage is the initial stage in this 4-D model, namely the stage where it is necessary to analyze the needs/objectives in this development research. This stage begins with understanding/defining the requirements in learning or analysis of the obstacles encountered in teaching. Developers need to analyze, collect and focus on the development requirements needed [15]. At this stage there are five processes, namely the front end analysis stage by knowing the problems encountered in the learning process, then the student analysis stage, namely knowing the characteristics of students through interviews and filling out questionnaires. Furthermore, task analysis is analyzing the contents of the learning unit to find out which model is suitable for learning. Then analyze the concept, find out the main concepts that will be taught, and finally formulate learning objectives.

2.   Design Stage

Designing learning devices that you want to develop. Compile reference tests, choose the format and initial design [16].

3.   Develop stage

Developing a product, namely LKPD. The development stage consists of an expert appraisal step (validity test) followed by revision and practicality test (development testing). The assessment on the validation process is the eligibility element for the contents of the LKPD, language elements, presentation elements and graphic elements. In practicality testing (practicality) that will be tested namely ease of use, time efficiency, the usefulness of the resulting LKPD. Three validators from the Chemistry Department of FMIPA UNP as lecturers validated this teaching material and 2 high school chemistry teachers as validity testers. Practicality was assessed by two teachers and by class XI students. The level of validity and the level of practicality can be seen from the measurement/testing of the LKPD that has been made.

Content validation analysis and product design teaching materials are based on categorical judgments that have been modified by Boslough and Paul (2008).

The validator will post a question, after which the validator provides an assessment regarding the question.   The assessment given by the validator in the form of a questionnaire is based on the acquisition rates obtained which are comparable to the criteria in **Table 1** . here is [17].

Table 1. Value/score of the Validity Sheet

Answer	SS	S	TS	STS
Score	4	3	2	1

The results of the assessment by the validator will be analyzed using the Aiken's V formula as follows:

$$V = \frac{\sum s}{[n(c-1)]} \quad s = r - lo$$

Information:

V   = Validity index

r   = The number given by the validator

n = The number of validators

l o = The lowest score in the scoring category

c = The number of categories chosen by the vlidator

Aiken's V scale can be seen in the table below:

V Scale Category

No	Aiken's V scale	Category
	1.$V \leq 0.8$	Invalid
	$V \geq 0.8$	Valid

3. Results and discussion

STEAM-PjBL interactive student worksheets (LKPD) on Reaction Rate material have been realized from research on the development of this teaching material. R & D (Research and Development) as a research method in this development research, and the model applied is 4- D which consists of 4 stages. The first stage is (1) define, (2) design, (3) development, (4) disseminate. The series of stages in this study only reached the development stage. On at the Development stage carried out by researchers until the validity assessment to measure the originality of the resulting product. This LKPD product is in the final stages of practicality. An overview of the LKPD made in **Figure 1** follows:

Figure 1 . LKPD overview is successful

1. Stage (Define)

a.   Preliminary analysis

Obtain initial information by making observations obtained from teachers by taking the results of interview reports from direct interviews with the chemistry teacher concerned. The first stage of this study also carried out interactions with students through an initial observation questionnaire. The information obtained from the results of interviews and filling out the questionnaire came from 3 schools selected Padang 10 High School, Padang 2 High School and Padang 13 High School. The results of this observation found that (1) the learning approach in each school used a scientific approach, not yet using STEAM (Science, Technology, Engineering, Art and Mathematics) as a new learning approach. (2) The learning model used has not used the PjBL (Project Based Learning) model. The three schools respectively apply Discovery learning and Guided Inquiry learning as learning models. (3) The learning process has not used practicum or made projects in the three schools. This has an impact on the lack of creativity and skills of students. (4) the LKPD used by students in several schools is not attractive because the LKPD is colorless and has not been equipped with supporting pictures and has not been able to improve students ' 4 C abilities.

b.   Student analysis

Based on observations from observations, an analysis was carried out on students, the results were obtained: (1) The learning outcomes of students were still far from expectations and many had not achieved completeness. (2) The results of the questionnaire were obtained from the three schools where there were still many points of lack of understanding of each point of learning the Reaction Rate material, namely 71.8% at SMA N 2, followed by SMA N 13 at 65.2% and SMA N 10 at 25.7 %. (3) The percentage of those who like chemical materials, especially the rate of reaction, is only 34.6% (4) The learning process is also seen from students who do not show enthusiasm.

c.   Task analysis

This reaction rate material has KD (Basic Competency) 3.5 and 3.6, where this KD will be reduced to GPA and formulated in learning objectives which will later become targets.

d.   Concept analysis

Identifying material descriptions at the Reaski Rate as outlined in the preparation of concepts related to the material to be presented. The conceptual framework is generated in this stage. Material analysis on Rection Rate is also carried out at this stage, which is obtained from the dimensions of knowledge (facts, concepts, principles, and procedures). Then the concept analysis (concept labels, concept definitions, concept types, concept attributes, concept hierarchies, examples, non-examples) will be outlined in the concept map.

e.   Making learning goals

The learning objectives of the Reaction Rate material which have been analyzed by material analysis and task analysis are summarized into the formulation of objectives in learning related material. The results of the two analyzes will be formulated in the form of learning objectives. The importance of determining learning objectives is to determine the objectives of learning in the product in the form of the developed LKPD and also determine the attitude or behavior of the object in the research.

2. **Stage (Design)**

A framework is produced as the initial design of the developed LKPD. The framework for LKPD starts with the cover (title, subject matter, class/semester, names of authors and supervisors, pictures related to reaction rate material or projects that students will make). Preface, table of contents, instructions for using LKPD, laboratory rules, symbols for hazardous chemicals, introduction to lab tools, KI, KD, GPA, learning objectives, material summaries, worksheets, evaluations and bibliography. Microsoft word as a tool in preparing worksheets and other applications.

The designed LKPD is also in accordance with the model and approach, namely PjBL as a model and STEAM as an approach in the learning process in its preparation. The PjBL model serves as a guide in the stages/sequence of learning, starting with (1) Questioning problems, (2) designing project planning designs, (3) Setting schedules, (4) Monitoring students and project progress, (5) Testing results and (6)) Testing the participants' knowledge [18].

The STEAM approach to this LKPD is also integrated into the learning process or designed project. Every field on steam namely (Steam, Technology, Engineering, Art, and Mathematics) is integrated in the projects created and in learning.

3. **Development stage (Develop)**

a. Validity test

The elemental parts of a LKPD need to be tested, namely the presentation elements/components, language components, presentation parts and graphical components [19] . Five validators have been determined to carry out the validation in accordance with a procedure where the assessment in validity testing can be carried out by 5 validators and at least 3 validators as expert opinions (judgment experts) [20] .

There are 3 lecturers from the Chemistry Department of FMIPA UNP as validators for validity as many as 3 people and 2 people from high school chemistry study teachers from the city of Padang. Processing of data results from filling out the questionnaire was processed using the Aikens's V index .
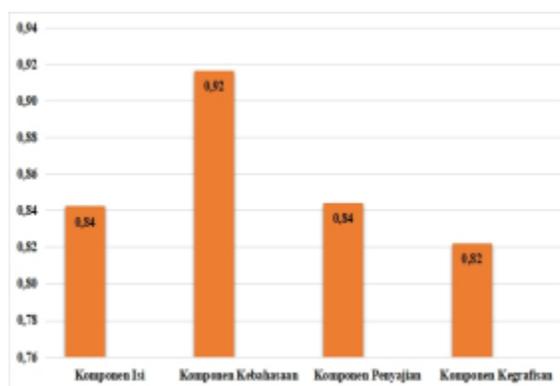
Figure 2. Graph of validity test results

The content eligibility component has a validity value of 0.84 based on the graph above. The validity value of the content component is in the valid category. This assessment is based on Reaction Rate material which is already related to the LKPD being developed, seen from KD and GPA to be achieved. The suggestions and input given by the validator on the content components of this teaching material have been revised accordingly. The product that has been developed already has valid content components because it is in accordance with the learning objectives of the related material and the applied curriculum.

Assessment in the language element is formed on: the readability of the text on the LKPD correctly (readability), the certainty/clarity of information, the suitability of using Indonesian language rules and clear sentences without causing doubts for the reader [20] . Based on the Aiken 's i V formula, it can be stated that the linguistic components used in this LKPD teaching material are correct and appropriate. These results were obtained after receiving comments from the validator on the language used in the previous LKPD, then improvements were made so that the results of the happiness component were based on a validity test of 0.92 which was in the valid category.

The results of the assessment of the presentation components are in the valid category with a score of 0.84. Testing the presentation of teaching materials is based on the coherence of the presentation of the material, the learning process with the approach or model used. So from the validity test score index it is found that the presentation on the LKPD is in accordance with the PjBL model set as well as the STEAM approach used which is also valid in the presentation of each field in this approach. The designed LKPD already has work instructions, appropriate layout, formulation of learning objectives, and clarity in the distribution of each GPA and material.

The graphical component can be seen in the graph, which has an Aiken's V formula of 0.82. The figures obtained show that from a graphical point of view the developed LKPD has a good graphical value, which is stated in the valid category. The importance of graphics in LKPD is to make the display attractive and attention-grabbing to students. Assessment is based on form, standard and typeface conditions that are suitable and legible, layout or positioning of interesting teaching materials, accuracy in selecting images and illustrations used, and the use of appropriate colors and the overall attractiveness of the design. Overall the assessment of the four components in the teaching materials in the form of LKPD is in the valid category, namely 0.85.

b. Revision

Revisions are made when during the validation process there are suggestions, input and comments on the teaching material products being developed. Improvements or revisions of this LKPD in order to produce a feasible and valid product which will later be tested. Before testing the practicality of a product, the validator has previously indicated that the product has been declared valid.

4. **Conclusion**

The conclusion of this development research is that teaching materials have been produced in the form of worksheets integrated with STEAM-PjBL (Science, Technology, Engineering, Art and Mathematic-Project Based Learning) on Reaction Rate material using the development model, namely 4-D. LKPD as teaching material has resulted in a validation level of 0.86 in the valid category.

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