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Development of LKPD Based on Project Based Learning Stoichiometry Material by Utilizing Organic Waste for Phase F SMA/MA

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Abstract
The project-based learning model is one of the learning models that supports the application of concepts in everyday life. From the results of the questionnaire given, Project Based Learning-based LKPD is needed and it is very important to compile Project Based Learning-based stoichiometry LKPD in supporting learning in the era of an independent curriculum. The type of research used is development research or Educational Design Research (EDR) with the Plomp development model by Tjeerd Plomp. The research was conducted at SMA Negeri 4 Padang with research subjects namely 3 Chemistry Lecturers FMIPA UNP, 2 SMA Negeri 4 Padang teachers and 9 students of class XI SMA Negeri 4 Padang. The object of research is LKPD based on project-based learning on stoichiometry material by utilizing organic waste for phase F SMA / MA. In terms of research, Plomp as a development study has 3 main stages, namely the initial research stage, the prototype formation stage, and the assessment stage. The results showed that all aspects assessed in each component of the validation of project-based learning-based LKPD on stoichiometry material by utilizing organic waste for phase F SMA / MA obtained an average V value of 0.92 with a valid category. The results are very practical for teachers with an average practicality of 91% and practicality for students is very practical with an average practicality of 89%. Based on the results of the study, it was found that the development of LKPD based on project-based learning on stoichiometric material by utilizing organic waste for phase F SMA / MA was developed valid and practical.

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INTRODUCTION

Chemistry is a discipline that requires deep understanding and critical thinking skills (Alsaleh, 2020; Caspari et al., 2018). The complex and interconnected concepts in chemistry demand students to have a reliable thinking system to effectively comprehend and apply the knowledge (Caspari et al., 2018). Therefore, an instructional model that can train higher-order thinking skills is needed to study chemistry content. Chemistry involves various interconnected concepts, ranging from atomic and molecular structures, chemical reactions, to thermodynamics and kinetics (Armstrong et al., 2018; Ashokkumar et al., 2020). Understanding one concept often requires comprehension of another. For instance, to understand chemical reactions, students need to grasp molecular structures and how atoms interact with each other. This complexity demands high-level analysis, synthesis, and evaluation skills (Liline et al., 2024).

A reliable thinking system includes critical and creative thinking skills, as well as problem-solving abilities (Cabrera & Cabrera, 2023). Critical thinking involves deep analysis, evaluation of evidence, and decision-making based on logic and existing evidence (Behar-Horenstein & Niu, 2011; Bellaera et al., 2021; Elder & Paul, 2020). Creative thinking involves the ability to generate new and innovative ideas (Akpur, 2020; Bïrgili, 2015). In the context of chemistry, critical and creative thinking are crucial for understanding complex concepts and developing solutions to chemical problems (Constable et al., 2019). One effective instructional model for training higher-order thinking skills is Project-Based Learning (PBL) (Amïn et al., 2020; Liu & Pásztor, 2022). PBL is a learning approach where students engage in real-world projects that are relevant to their lives. These projects are designed to challenge students to solve complex problems, conduct research, and apply their knowledge in authentic situations (Almulla, 2020; Anazifa & Djukri, 2017).

Warsono (2013) defines project-based learning as a comprehensive learning approach in which learners engage in investigative activities, work together, and take place on an ongoing basis. In the 2013 Curriculum Implementation Teacher Training Materials book, it is explained that each learning model has a specific purpose to be applied. Project-based learning (PjBL) aims to make learners better at solving project problems, gain more knowledge from the applied model, become more active in the learning process, and improve their ability to cooperate and interact with each other (Kemndikbud, 2014). According to Bagheri et al. (2013), one of the advantages of project-based learning is that learners can determine their own project objectives and choose the most appropriate project to do in groups. In conclusion, project-based learning emphasizes learning to learners and is related to the material to be learned. In addition, learners can acquire skills through projects, both in the classroom and outside the classroom.

Learning is usually boring for students because it is not interesting and monotonous (Zebua & Siahaan, 2021). The success of the learning process tends to depend on a number of supporting components. Teaching staff, recommendations and infrastructure, learner motivation, and the education system used are supporting components. Teaching materials are very important for the learning process. Teaching materials are learning components used by chemistry teachers to teach their students (Salfrika, 2016). One of the teaching materials used by teachers in the teaching and learning process is the Learner Worksheet (LKPD).

In general, the new findings show that many schools and teachers are still not ready to face the challenges demanded by the independent curriculum. Based on the needs analysis questionnaire of chemistry teachers conducted at SMA Negeri 3 Padang and SMA Negeri 4 Padang, it was found that 4 out of 6 chemistry teachers in both schools had never conducted lessons related to stoichiometry material using the Project Based Learning learning model and had never compiled or even used Project Based Learning-based stoichiometry LKPD. The results of the analysis obtained from the chemistry teacher needs analysis questionnaire stated that Project Based Learning-based LKPD is needed and it is very important to prepare Project Based Learning-based stoichiometry LKPD in supporting learning in the era of the independent curriculum.

Learning with the PjBL model has its own learning flow and is different from other learning models. Where this learning model organizing the class in a project which has syntax that must be done (Almulla, 2020; Condliffe, 2017). There are seven stages of PjBL, where the

PjBL syntax includes: a) Start with essential question, learning begins with an essential question, which is a question that assigns learners to an activity. These questions are organized around real-world topics and begin with an in-depth investigation. These questions should be difficult to answer and may encourage learners to create projects. Such questions are usually divergent, provocative, challenging, and require higher-order thinking skills and are closely related to learners' lives (Almazroui, 2023; Anazifa & Djukri, 2017; Diana et al., 2021). Teachers strive to ensure that the material taught is interesting to learners; b) Design project, project planning is done collaboratively by the teacher and learners, so that learners feel 'ownership' of the project. This planning includes the rules of the game, activities that can help answer important questions, ways of combining different possible materials, and information about materials and tools available to help complete the project; c) Create schedule, teachers and learners work together to create a schedule of activities needed to complete the project.

For teachers to track learning progress and complete projects outside of class, an agreed-upon timetable should be agreed upon; d) Monitoring the students and progrees of the project, during the project, the teacher is responsible for monitoring learners' activities. Monitoring is done by facilitating learners in every process. In other words, the teacher acts as a mentor for learners' activities. A rubric that can record all important activities is created to make monitoring easier; e) Assess the outcome, assessment is carried out to assist teachers in measuring the achievement of competency standards, play a role in evaluating the progress of each learner, provide feedback on the level of understanding that students have achieved, and assist teachers in developing the next learning strategy; e) Evaluate the experience,, after the learning process is complete, the teacher and learners reflect on the activities that have been carried out and the results of the project. This reflection is done both individually and in groups. Teachers and learners talk to improve performance during the learning process (Almazroui, 2023; Hulyadi et al., 2024). Learners are asked to tell what they felt and experienced while completing the project. In the end, new findings are discovered or a new question, to solve the problem posed in the first stage of learning. (George Lucas Education Foundation, 2005).

Research conducted by (Anisatul et al. 2021; Ardiansah & Zulfiani, 2023) on the development of STEM-oriented LKPD with the Project Based Learning model on electrolyte and non-electrolyte solution materials by utilizing surrounding materials, in this study it was found that the LKPD developed was valid, practical, and effective for use by students. Based on research conducted by (Lili et al. 2017) on how the Effectiveness of Project Based Learning-based LKPD to Improve Students' Science Process Skills. Where the results showed that the use of project-based learning-based LKPD was effective in improving students' science process skills.

Stoichiometry material basically tends to calculations, in accordance with the demands of the curriculum the learning process emphasizes providing direct experience to students to develop competencies in order to explore and understand the surrounding environment scientifically. Therefore, the chemistry learning process must be improved, by changing the learning pattern from memorizing to understanding the learning material. Learners can be actively involved in every learning process to be able to understand the material, as well as the independent curriculum, students are required to think critically about the problems given to get solutions to existing problems (Kemendikbud, 2020).

Based on the description that teaching materials are needed in conducting learning developed in accordance with the provisions of the applicable curriculum and analysis of the needs of chemistry teachers in schools. Active learning can be done by direct observation and connecting problems in the surrounding environment so that students can easily understand and solve problems. In addition, one of the most needed at SMAN 4 Padang is LKPD which is not yet available to support the learning process chemistry learning, especially stoichiometry material so that researchers use LKPD project-based learning for students to explore there.

Preliminary research results indicate that the application of instructional models supporting the Merdeka Belajar curriculum is still not optimally implemented. Chemistry education is still dominated by direct material delivery, which has not effectively trained students' thinking and psychomotor skills. Instructional tools that integrate contextual conditions with instructional models supporting the Merdeka Belajar curriculum, such as PjBL, PBL, and Blended Learning, are essential to be implemented. LKPD designed with the PjBL model becomes one of the solutions to enhance students' thinking competencies. The implementation of PBL in chemistry education can improve students' higher-order thinking skills (Almazroui, 2023; Loyens et al., 2023). Through PBL, students are encouraged to conduct experiments, collect and analyze data, and present their findings. For example, a project on utilizing organic waste to produce beneficial chemicals can involve students in various activities such as literature research, laboratory experiments, and presentation of results (Barua et al., 2023; Sofokleous et al., 2022).

Anazifa & Djukri (2017) and Hulyadi & Muhali (2023) state that Project-Based Learning (PBL) is a learning approach that uses projects as the central activity of the learning process. Students are encouraged to conduct experiments, collect and analyze data, and present their findings. PBL aims to develop critical thinking, collaboration, and problem-solving skills among students (Dabbagh, 2019; Liu & Pásztor, 2022). This approach is highly relevant in chemistry education, especially in the context of environmental issues such as utilizing organic waste to produce beneficial chemicals.

Barua et al. (2023) and Sofokleous et al. (2022) state that utilizing organic waste is an important issue in the context of sustainability and the environment. Organic waste can be processed into various beneficial chemicals such as biogas, bioethanol, and organic fertilizers. This processing involves various chemical and biochemical reactions that can be an interesting and contextual learning topic in chemistry. Contextual and meaningful learning can be achieved by addressing environmental and socio-economic issues such as energy problems, climate change, and food crises (Adger et al., 2003; Carleton & Hsiang, 2016; Gasper et al., 2011). Using organic waste to produce biogas as a renewable energy source allows students to learn about chemical reactions in the anaerobic fermentation process and its impact on energy security (Balat, 2008; Bhowmik et al., 2017). This context can be linked to stoichiometry concepts in chemistry. Concentration studies and moles of reacting and formed substances can be examined during the biogas or bioethanol production process. Utilizing organic waste to reduce greenhouse gas emissions allows students to learn how organic waste processing can reduce methane and carbon dioxide in the atmosphere (Khan, 2012; Schernikau & Smith, 2022). Developing instructional tools that address environmental issues is crucial for preparing generations that are adaptive to environmental changes and the demands of changing times. LKPD is an instructional tool that can guide the learning process more effectively.

Lembar Kerja Peserta Didik (LKPD) addressing environmental and socio-economic issues can provide meaningful learning (Hulyadi et al., 2023). Various studies have shown that utilizing organic waste has great potential in environmental management and renewable energy production. A study by Kafle & Kim (2013) shows that anaerobic fermentation can convert organic waste into biogas, an efficient renewable energy source. Additionally, research by Matheri et al. (2017) confirms that biogas has high energy content and can reduce greenhouse gas emissions. Project-Based Learning (PBL) that addresses the issue of utilizing organic waste to produce beneficial chemicals can provide meaningful and contextual learning. Through literature research, laboratory experiments, and result presentations, students can develop critical thinking, collaboration, and problem-solving skills. LKPD addressing environmental and socio-economic issues such as energy, climate change, and food crises can enhance the relevance and meaningfulness of chemistry education.Based on the background that has been described, the researcher is encouraged to conduct a study entitled Development of LKPD Based on Project Based Learning Stoichiometry Material by Utilizing Organic Waste for phase F SMA/MA.

METHOD

The type of research used is development research or Educational Design Research (EDR) with the Plomp development model by Tjeerd Plomp (Plomp, T & Nieveen N., 2013) (Sitanggang et al., 2022). EDR is a systematic study to design, develop and evaluate educational interventions such as programs, teaching-learning strategies, learning materials, and the products developed can be used as solutions to complex problems in education (Mawardi, M & Nur, M. I., 2022). There are three stages in the development of Plomp, (1) preliminary research, (2) development or prototyping phase, and (3) assessment phase. Plomp's development stages can be seen in Figure 1. The research was conducted at SMA Negeri 4 Padang with research subjects namely 3 Chemistry Lecturers FMIPA UNP, 2 SMA Negeri 4 Padang teachers and 9 students of phase F SMA Negeri 4 Padang. The object of research is LKPD based on project-based learning on stoichiometry material by utilizing organic waste for phase F SMA/MA.

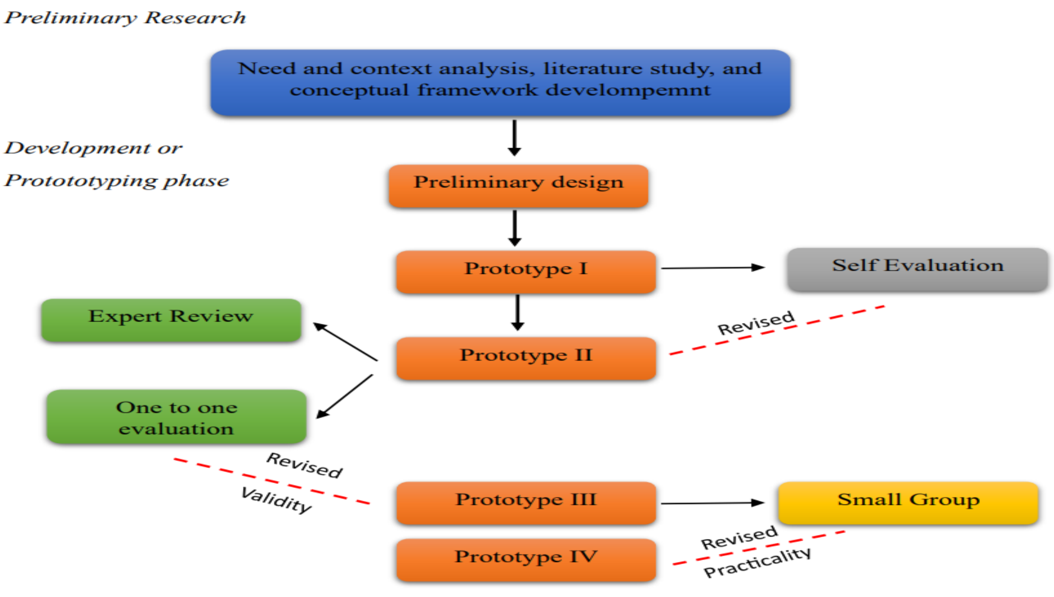


Figure 1. Research Desain

In the initial research stage, several stages are carried out, namely needs and context analysis, literature review, development of a conceptual or theoretical framework for research. The emphasis is mainly on content validity, not on consistency and practicality (Plomp & Nieveen, 2007). The needs analysis was carried out to find out the problems commonly experienced by students and teachers in learning chemistry, especially stoichiometry material. The needs analysis was carried out by questionnaires and interviews with chemistry teachers and filling out questionnaires by students through google from. At the literature study stage, it is carried out to find references and sources that are related and correlated with the research objectives to be carried out. References and sources that can be used as a benchmark are books, journals, thesis, articles and things that make it possible to be used as references and sources of reference in conducting research. At this stage, the conceptual framework is a relationship or link between one concept and another from the problem to be studied. To develop a conceptual framework based on the needs analysis, context, and literature study that has been done previously.

After conducting the preliminary research stage, then the development or prototype stage is carried out. At the prototype stage, a formative evaluation will be conducted. In prototype I, designing and compiling the content of the product material, then conducting a self-evaluation. Self-evaluation is carried out to review the completeness of the components in the developed teaching materials. If there are deficiencies, revisions will be made until prototype II is produced.

Prototype II is the result of improvements from prototype I, then expert review and one to one evaluation. Expert review is carried out to provide an assessment and suggestions for the LKPD being developed. This assessment was carried out by chemistry lecturers and chemistry teachers who acted as validators. Then, one to one evaluation was carried out to find out student responses regarding the project-based learning LKPD developed. Prototype III is the result of improvements from prototype II, Prototype III was carried out small group trials by teachers and students to assess the practicality of the teaching materials developed until prototype IV was produced which is a refinement of prototype III.

The data obtained was analyzed using the Aikens'V formula based on categorical judgments modified from Boslaugh and used for validity analysis. With categorical judgments, validators are given statements to convey their assessment of each statement. Where Aiken's V formula is as follows.

$$V = \frac{\varepsilon s}{n(c-1)}$$

$$s = r - lo$$

Description:

S = The score assigned by the validator minus the lowest score of the category used

r = validator's preferred category score

Io = the lowest score in the scoring category (in this case = 1)

c = the highest score in the assessment category (in this case = 5)

n = many validators

The level of validity is seen in the results of the calculation of the V score obtained. Aiken's V scale is listed in the following table.

Table 1. Criteria for Kevalidan

Scale Aiken’s V	Validity
$V \geq 0,80$	Valid
$V < 0,80$	Invalid

(Aiken, L.R., 1985)

While the data obtained from the practicality questionnaire, analyzed using the following formula:

$$NP = \frac{R}{SM} \times 100$$

Desccription:

NP = Percent value sought or expected

R = Raw score obtained by the student

SM = Ideal maximum score of the test concerned

100 = Fixed number

Table 2. Category of Practicality Level

Value	**Validity**
86% - 100%	Very Practical
76% - 85%	Practical
60% - 75%	Practical Enough
55 % - 59 %	Less Practical
≤ 54 %	Not Practical

(Purwonto, 2012)

RESULTS AND DISCUSSION

The results of the research on the development of LKPD based on project-based learning on stoichiometry material by utilizing organic waste for phase F SMA / MA with the type of educational research. design research (EDR) using the Plomp model can be described as follows.

Preliminary Research

At the preliminary research stage, several stages were carried out, namely needs and context analysis, literature study, conceptual framework development (Plomp & Nieveen, 2007). The research results obtained from each stage of preliminary research are as follows:

Needs and Context Analysis

At the needs analysis stage, interviews and questionnaires were given to chemistry teachers in two high schools in Padang city as well as filling out questionnaires by students via Google from. The questionnaires were completed by three teachers from SMAN 3 Padang and three teachers from SMAN 4 Padang. Based on the results of the exploration, it is known that learning books are available that support students in the learning process, especially stoichiometry material. This supports the use of PjBL-based LKPD on stoichiometry material, so that students can use concepts to complete projects contained in PjBL-based LKPD on stoichiomteri material. This can improve students' critical thinking skills.

According to (Zakiyah et al, 2018) stoichiometry material is still considered difficult for most high school students, because the material is quite complex to understand and involves a lot of mathematical concepts in solving calculation problems. In the context analysis of stoichiometry that is deepest in the independent curriculum teaching materials in the form of the concept of moles, reaction equivalence, molecular formulas and empirical formulas, limiting reagents, and percent yield (Brady et al., 2012).

One of the learning models that is in accordance with the demands of the independent learning curriculum is the PjBL learning model. Based on Irvan's research (2021), there are several characteristics of the independent curriculum, namely, project-based learning in character and skill development that is synchronized with Pancasila, focused on essential materials, learning that is carried out in a flexible form depending on the ability of each student.

In the needs and context analysis stage, it is carried out by distributing observation questionnaires to teachers and students at SMAN 4 Padang. Based on the results of the observation questionnaire, it was found that the chemistry teacher at SMA 4 Padang had used LKPD in the learning process, but the implementation of the learning model used had not been implemented properly. In the learning process only uses LKPD but in accordance with the syntax that must be done at each stage of the learning model used.

According to Warsono (2013), defines project-based learning as a comprehensive learning approach where learners are involved in investigative activities, work together, and take place on an ongoing basis. Project-based learning aims to make learners better at solving project problems, gain more knowledge from the applied model, become more active in the learning process, and improve their ability to cooperate and interact with each other (Kemndikbud, 2014).

At this stage, it was also found that LKPD was the preferred teaching material by students at SMAN 4 Padang, where LKPD is one of the ways that can support the application of the Merdeka curriculum because LKPD is able to foster students' ability to think creatively. LKPD developed by considering the needs of students and by using a project-based learning model is one way to implement an independent curriculum.

Literature Review

Literature studies are conducted to obtain sources and references related to research. The results of the literature study carried out which underlie this research are the validity, practicality, and effectiveness of PjBL-based LKPD to improve students' science process skills. The results of the literature review used in this study are the Effectiveness of Project Based Learning-based LKPD to Improve Students' Science Process Skills conducted by (Lili, M., Sunyono, Abdurrahman). This proven with an increase in students' science process skills of 0.70 obtained from the N- Gain average.

This research is in line with research conducted by (Siti, E, S, S., et al.,2023) explaining that teaching materials in the form of LKPD based on project-based learning obtained 0.725 obtained from the average N-Gain, with 88.35% of students' responses. Where activities in the learning stage have a positive impact on improving students' critical thinking skills.

Develompment of Conceptual Framework

The development of the conceptual framework resulted from the needs and context analysis stage of needs and context and literature study. The results of the analysis that have been carried out require independent curriculum chemistry learning resources, especially on stoichiometry material, so it is necessary to develop teaching materials in the form of LKPD to support independent curriculum learning on stoichiometry material. The development of the conceptual framework is made in the form of a scheme which can be seen in Figure 2.

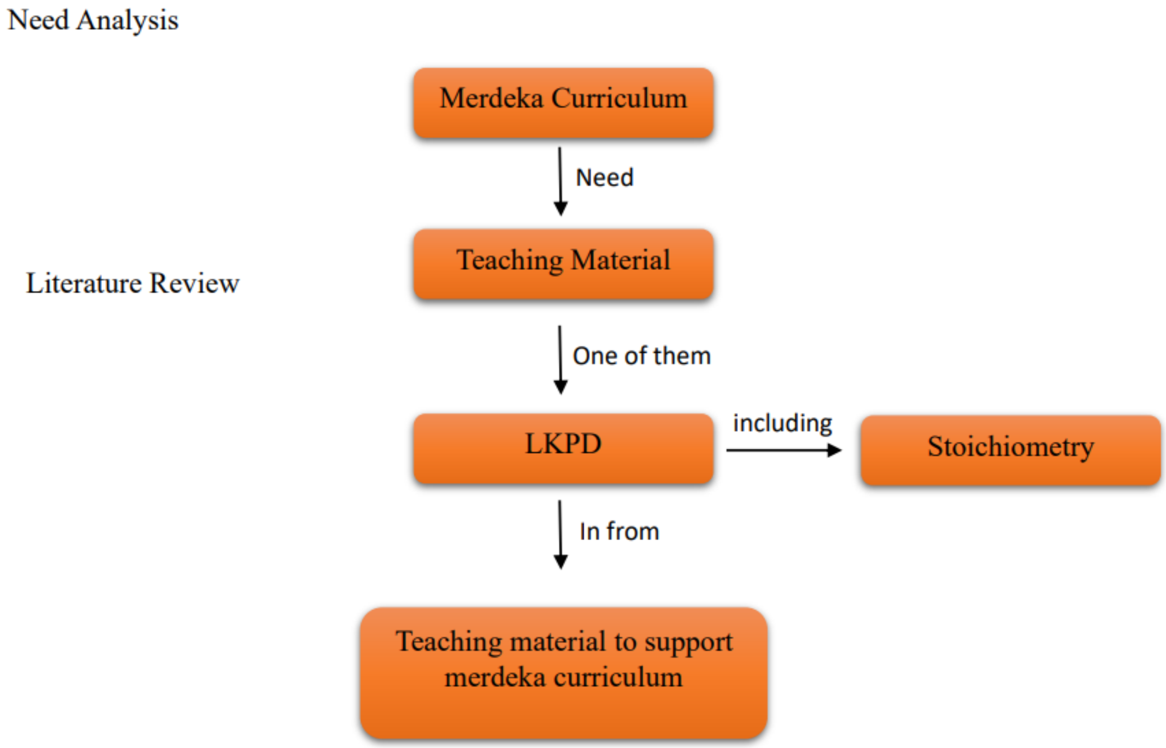


Figure 2. Conceptual Framework

Prototyping Phase

This development or prototype stage is carried out to produce products in the form of teaching materials to support merdeka curriculum learning on valid and practical stoichiometry material. The stages in the prototype are divided into four stages which can be described as follows:

Prototipe I

At this stage, the product design is carried out in the form of project-based learning-based LKPD found during the initial research phase. Researchers have a reference for LKPD components in advance that are in accordance with the demands of the Merdeka curriculum. The result of prototype I is the initial product of project-based learning-based LKPD which can be used as teaching material specifically for stoichiometry material. At this stage, a self-evaluation is carried out to see the completeness of the learning LKPD components that have been developed. Components of teaching materials consists of a cover, preface, table of contents, instructions for use, learning outcomes, learning objectives, flow of learning objectives, syntax of the learning model, up to the assessment at the end of the LKPD and is also equipped with a bibliography.

Prototipe II

At the prototype II stage, a formative evaluation of the results of prototype I was carried out. The formative evaluation carried out is in the form of self evaluation (self research) using a checklist of prototype I. The results of the evaluation carried out on prototype I obtained that the LKPD developed was complete and in accordance with the components of prototype I. The results of the evaluation carried out on prototype I obtained that the LKPD developed was complete and in accordance with the components of the prototype.

At this stage, from the results of prototype II, formative evaluation will be carried out in the form of expert review and one-to-one evaluation. This process is carried out to obtain whether or not a product is valid. The following is an explanation of prototype III. The results of prototype II, will be validated by five validators consisting of three chemistry lecturers FMIPA UNP and two chemistry teachers SMAN 4 Padang. In this validity test using an assessment instrument in the form of a validation questionnaire. The components assessed are content and material components, linguistic components, presentation components, and graphical components. From the results of data analysis of filling in the validity questionnaire of project-based learning-based LKPD on stoichiometry material by utilizing organic waste for phase F SMA / MA by five validators. The results of the content and construct validity analysis can be seen in Table 3.

Table 3. Results of Validation Data Analysis on All Aspects

Aspects assessed	V	Category
Content and Material Component	0,91	Valid
Language Component	0,92	Valid
Presentation Component	0,91	Valid
Graphics Component	0,92	Valid
Average	0,92	Valid

It is found that all aspects that are assessed in each component of the validation of project-based learning-based LKPD on stoichiometry material by utilizing organic waste for phase F SMA/MA, the average V value is 0.92 with a valid category. The results of the content feasibility test obtained a value of 0.91 with a valid category.

According to (Cahyadi, 2019) teaching materials must be prepared based on specific learning objectives and to achieve these competencies the content in teaching materials is usually sourced from relevant textbooks. The results of testing the language component obtained a value of 0.92 with the valid category. This is in accordance with the Ministry of National Education (2008) which states that to produce good teaching materials, it is necessary to evaluate the language component which consists of readability, clarity of information, conformity with good and correct Indonesian language rules and the use of clear and concise language. The results of the presentation component test obtained a value of 0.91 with a valid category. According to (Magdalena et al, 2020) teaching materials made systematically will facilitate students in the learning process. The test results of the language component obtained a value of 0.92 with the valid category. This is in accordance with the Ministry of National Education (2008) which states that to produce good teaching materials, it is necessary to evaluate the language component which consists of readability, clarity of information, conformity with good and correct Indonesian language rules and the use of clear and concise language. The test results of the graphical component obtained a value of 0.92 with a valid category. Based on the results of the assessment conducted by the validator, the average value of the Aikens V index is 0.92. Based on table 1, the validity questionnaire is included in the valid category. Thus the teaching materials developed are declared valid. After the teaching materials developed are valid, a one to one evaluation test is carried out.

The one to one evaluation stage is carried out after producing the product from the expert review stage. At this stage, it was carried out on three students through interviews with students and filling out questionnaires. The following are the results of the one to one evaluation questionnaire that has been carried out.

The results of this one to one evaluation are carried out as an overview of whether the product developed is suitable for use in classroom learning for stoichiometry material in accordance with the experience of students. Based on the results of one to one, it can be analyzed that from the cover, the appearance of the design, the language used is clear and easy for students to understand and the images used are in accordance with stoichiometric material and interesting, thus helping students in understanding stoichiometric material.

Based on the results of one to one, it can be analyzed that from the cover, the appearance of the design, the language used is clear and easy for students to understand and the images used are in accordance with stoichiometric material and interesting, thus helping students in understanding stoichiometric material.

Prototipe III

Expert judgment and one to one evaluation tests that have been carried out produce a valid prototype III. At this stage, the practicality test was carried out in the form of a small group evaluation test of the product through a pre-skill questionnaire. The practicality test was conducted to two chemistry teachers and 9 students of class XI SMAN 4 Padang.
The assessment carried out in this practicality test is based on aspects of ease of use, appearance, learning efficiency, and benefits in learning. Learning begins by using the developed teaching materials. Students were also asked to fill out a practicality questionnaire which would later be used as the practicality value of the developed LKPD. In addition, the questionnaire was also given to chemistry teachers at SMAN 4 Padang. Based on the Table, the average percentage of practicality test results by teachers is 91%, while the average

percentage of practicality test results by teachers is 89%. Based on Table 2, the practicality test is included in the very practical category.

Table 4. Data Analysis of Teacher Practicality on All Aspects

Aspects assessed	P-value	Category
Ease of use	93%	Very Practical
Display of	90%	Very Practical
Learning Efficiency	95%	Practical
Benefits of LKPD	85%	Very Practical
Average	91%	Sangat Praktis

Table 5. Analysis of Practicality Data for Learners on All Aspects

Aspects assessed	P-value	Category
Ease of use	89%	Very Practical
Display of	89%	Very Practical
Learning Efficiency	84%	Practical
Benefits of LKPD	92%	Very Practical
Average	89%	Very Practical

The results of the practicality test by students and teachers showed that the presentation of the material used was easy to understand. The content of the material provided is easy for students to understand. Practice questions can help students in understanding stoichiometry material. It can be concluded that the teaching materials developed are categorized as very practical. This is in line with research conducted by (Aasma, et al., 2018) and (Rahmi, C., 2023) which suggests that practical stoichiometry teaching materials are used in the learning process. The results of the LKPD formation stages can be observed in Figure.

STOIKIOMETRI

MEETING 1

Learning Objective:

Learners are expected to be able to explain the concept of mole and analyze the relationship between mass, volume, number of particles, and number of moles of a substance in chemical calculations.

Start With Essential Question

Waste is one of the biggest problems in every country. In fact, from time to time, the amount of waste does not decrease, especially organic waste. Do you know what organic waste actually is?

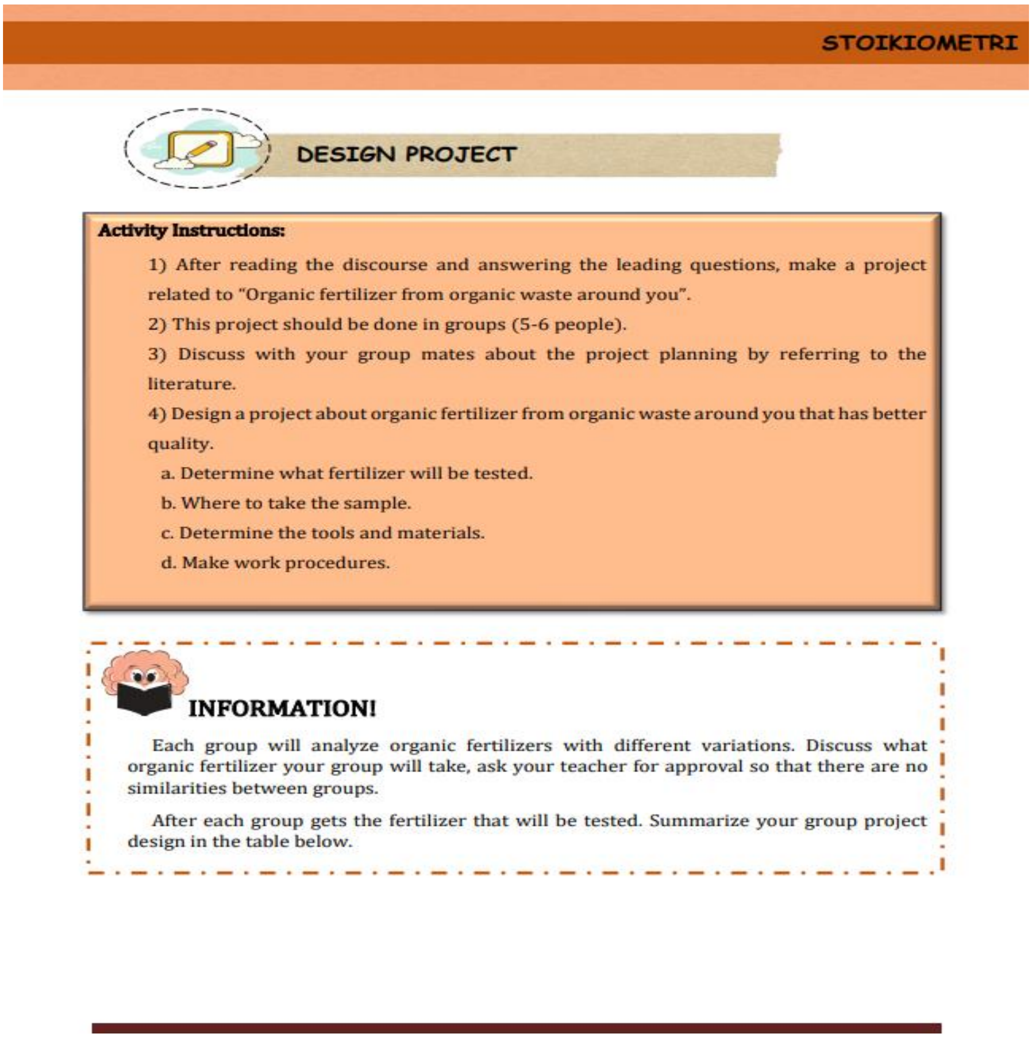
Source: http://www.orami.co.id Source: http://agri.kompas.com Source: http://www.kompasiana.com Source: http://www.calonpintar.com

Figure 1: Organic Waste

Organic waste is the remaining material or waste that can be recycled and comes from living things, such as food waste, waste of living things, or plant waste. In other words, organic waste is residual material or waste obtained from the production process or activities, both activities in the household realm and the industrial realm. This organic waste is waste or waste that is easily decomposed through several natural processes.

Figure 3. The first syntax of PjBL

Figure 3. Shows the first syntax of the project-based learning model, where learning begins by providing questions that can assign learners to do an activity. The question is organized around a real-world topic and begins with an in-depth investigation. The question should be difficult to answer, so as to encourage learners to create a project.



STOIKIOMETRI

DESIGN PROJECT

Activity Instructions:

1) After reading the discourse and answering the leading questions, make a project related to "Organic fertilizer from organic waste around you".
2) This project should be done in groups (5-6 people).
3) Discuss with your group mates about the project planning by referring to the literature.
4) Design a project about organic fertilizer from organic waste around you that has better quality.
   a. Determine what fertilizer will be tested.
   b. Where to take the sample.
   c. Determine the tools and materials.
   d. Make work procedures.

INFORMATION!

Each group will analyze organic fertilizers with different variations. Discuss what organic fertilizer your group will take, ask your teacher for approval so that there are no similarities between groups.

After each group gets the fertilizer that will be tested. Summarize your group project design in the table below.

Figure 4. Second Syntax of PjBL

Figure 4. Project planning is done collaboratively by teachers and learners, so that learners feel 'ownership' of the project. The activities carried out in this syntax are to find various information about materials and tools that will be used to help in completing the project.

STOIKIOMETRI

CREATE SCHEDULE

A. Timeline Group

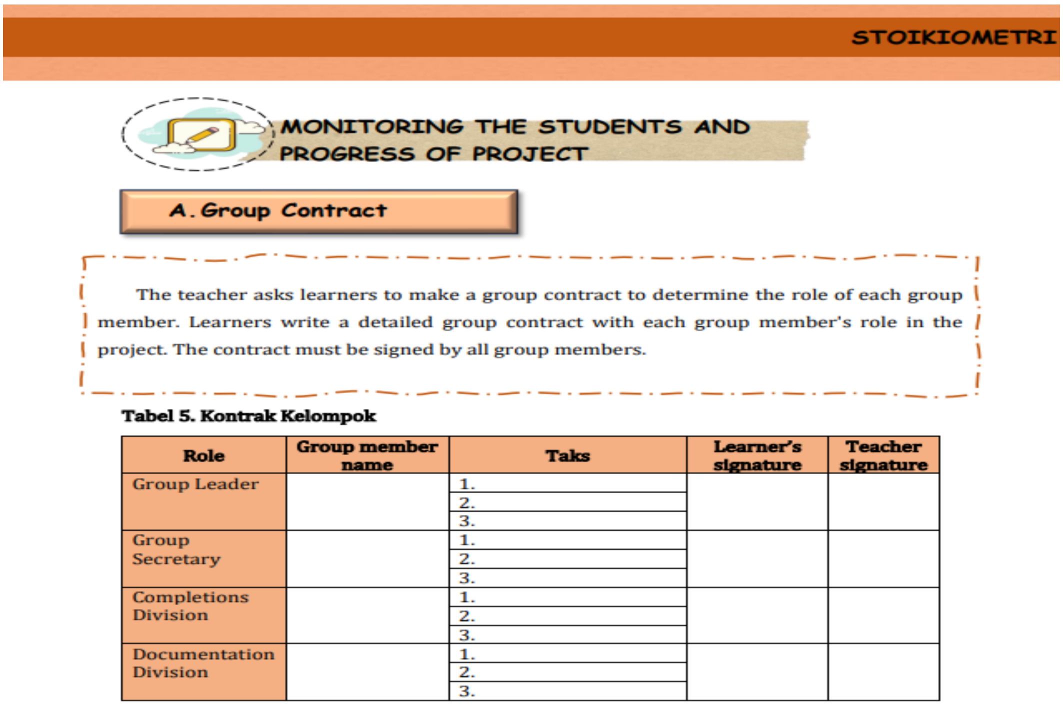
Discuss with your group mates the scheduling of project activities that will be carried out for 3 weeks with 5 meetings. Give a check mark (√) in the column below according to the mutual agreement! don't forget to upload the group work documentation on the link provided!

Tabel 1. Timeline Group

No	Activity	Week 1							Week 2							Week 3				
		Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
1.	Discussing the project draft																			
2.	Reporting the project draft to the teacher																			
3.	Reviewing the project draft																			
4.	Equip tools and materials needed																			
5.	Project implementation																			
6.	Making a project report																			
7.	Doing group presentation																			

Figure 5. Third Syntactic of PjBL

Figure 5. Teachers and learners work together to create a schedule of activities needed to complete the project. Activities undertaken at this stage include (1) creating a timetable for completing the project, (2) setting an end date for the project, (3) encouraging learners to plan new things, (4) teaching learners what to do when they make things that do not fit into the project, and (5) asking learners to provide an explanation (rationale) of their reasons for choosing the timing. For teachers to track learning progress and complete projects outside of class, an agreed-upon timetable should be agreed upon.



STOIKIOMETRI

MONITORING THE STUDENTS AND PROGRESS OF PROJECT

A. Group Contract

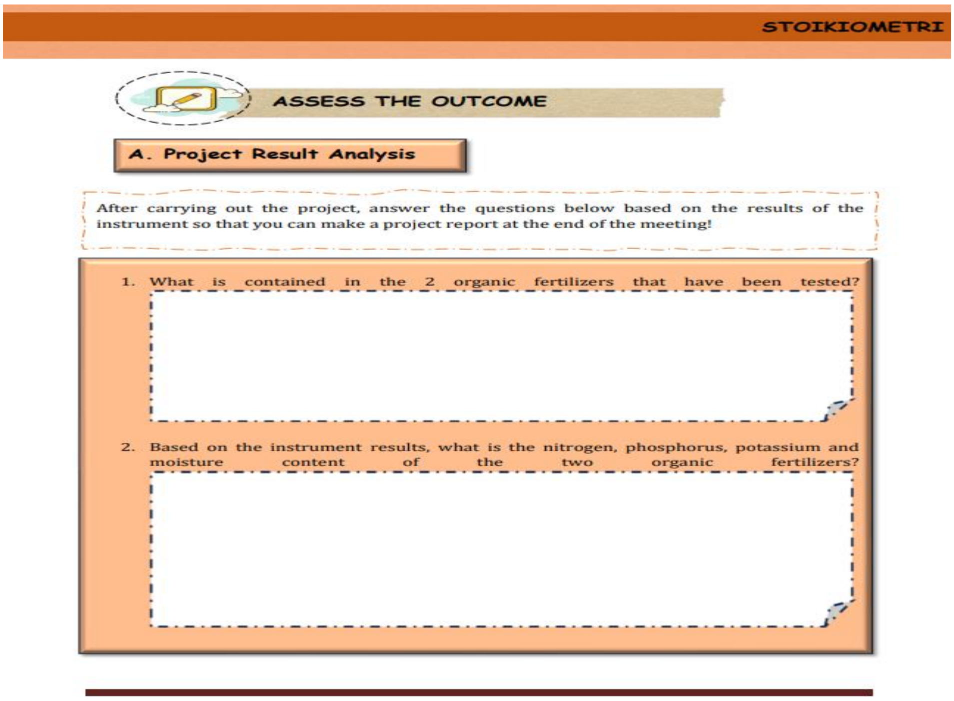
The teacher asks learners to make a group contract to determine the role of each group member. Learners write a detailed group contract with each group member's role in the project. The contract must be signed by all group members.

Tabel 5. Kontrak Kelompok

Role	Group member name	Taks	Learner's signature	Teacher signature
Group Leader		1. 2. 3.		
Group Secretary		1. 2. 3.		
Completions Division		1. 2. 3.		
Documentation Division		1. 2. 3.		

Figure 6. Fourth Syntax of PjBL

Figure 6. During the project, the teacher is responsible for monitoring learners' activities. Monitoring is done by facilitating learners in every process. In other words, the teacher acts as a mentor for learners' activities. A rubric that can record all important activities is created to make monitoring easier.



STOIKIOMETRI

ASSESS THE OUTCOME

A. Project Result Analysis

After carrying out the project, answer the questions below based on the results of the instrument so that you can make a project report at the end of the meeting!

1. What is contained in the 2 organic fertilizers that have been tested?
2. Based on the instrument results, what is the nitrogen, phosphorus, potassium and moisture content of the two organic fertilizers?

Figure 7. Fifth Syntax of PjBL

Figure 7. Assessment is carried out to assist teachers in measuring the achievement of competency standards, play a role in evaluating the progress of each learner, provide feedback on the level of understanding that students have achieved, and assist teachers in developing the next learning strategy.

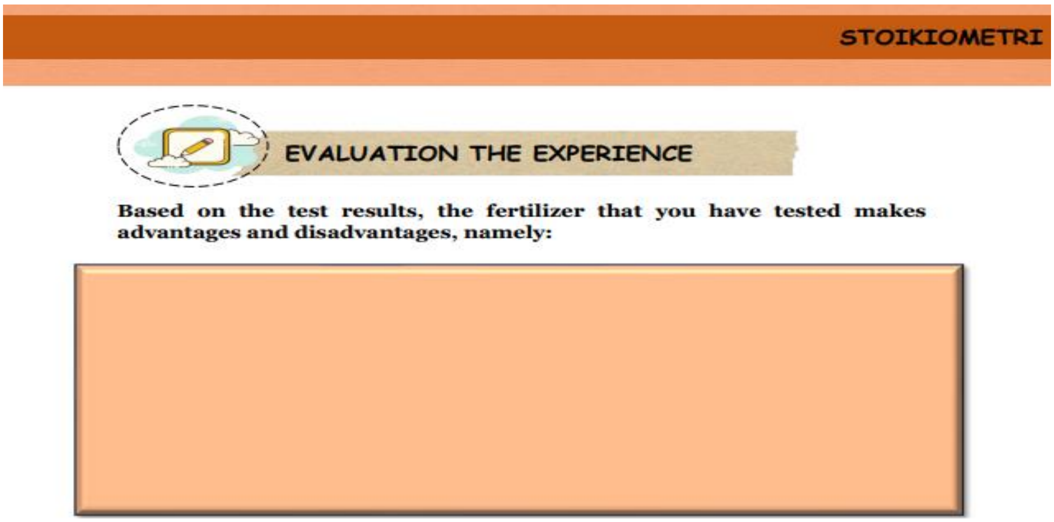


Figure 8. Sixth Syntax of PjBL

Figure 8. After the learning process is complete, the teacher and learners reflect on the activities that have been carried out and the results of the project. This reflection is done both individually and in groups. Teachers and learners talk to improve performance during the learning process. Learners are asked to tell what they felt and experienced while completing the project. In the end, new findings, or new questions, are found to solve the problem posed in the first stage of learning. The Learner Worksheet (LKPD) includes a number of basic activities that must be carried out by learners to improve their understanding. LKPD has learning outcomes that must be met (Silfi & Adriantoni, 2018). The components of LKPD are as follows: 1) Title, subject, semester, and place; 2) Learning instructions; 3) Components to be achieved; 4) Supporting information; 5) Tasks and work steps; 6) Assessment (Daryanto and Dwicahyono, 2014).

In general, LKPD is a learning tool as equipment or means of supporting the implementation of the learning plan. According to (Nurdin and Adriantoni, 2016) Learner Worksheets are guides for students used in investigation or problem solving activities. Learner worksheets can be used as a guide for developing cognitive aspects as well as a guide for developing all aspects of learning through experimentation or demonstration. In the developed LKPD, where project-based learning-based LKPD contains several components including a cover that characterizes the developed LKPD, foreword, table of contents, instructions for use which will be a benchmark in using project-based learning LKPD, learning outcomes, learning objectives, flow of learning objectives of PJBL syntax compiled based on instructions for use and bibliography.

This project-based learning-based LKPD has its own advantages compared to other learning models. One of the advantages of project-based learning is that students can determine their own project objectives and choose projects to be carried out in groups. Project-based learning emphasizes learning to students related to the material to be learned. In addition, learners can acquire skills through projects, both in the classroom and outside the classroom.

CONCLUSION

The results showed that project-based learning-based LKPD on stoichiometry material by utilizing organic waste for phase F SMA / MA which had been tested for validity obtained an average score of 0.92% which was categorized as valid. The results of the practicality test on the teacher obtained an average score of 91% and on students of 89% which was categorized as very practical. Based on the results of the study, it was found that the development of project-based learning based LKPD on stoichiometry material by utilizing organic waste for phase F SMA/MA developed was valid and practical.

RECOMMENDATIONS

This research is limited to validity and practicality tests, so it is recommended to conduct an effectiveness test on the products developed.

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