



# Journal of Educational Sciences

Journal homepage: <https://jes.ejournal.unri.ac.id/index.php/JES>



P-ISSN  
2581-1657

E-ISSN  
2581-2203

## Development of Steam-Pjbl Integrated LKPD on Acid and Based Materials For Class XI SMA

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### ARTICLE INFO

#### Article history:

Received: 26 Oct 2022

Revised: 04 April 2023

Accepted: 07 April 2023

Published online: 24 April 2023

#### Keywords:

R&D;

STEAM;

PjBL;

Acid dan Based

### ABSTRACT

This study aims to develop teaching materials in the form of Student Activity Sheets (LKPD) which are integrated in Science, Technology, Engineering, Arts and Mathematics – Project-Based Learning (STEAM-PjBL) on Acids and Bases material and are used to determine the level of validity and practicality of the LKPD that is used. developed. This research is a research (R&D) with a 4-D development model. This 4-D model has four stages, namely the stages of define, design, develop and disseminate. However, the dissemination stage was not carried out. This study used instruments in the form of content and construct validation questionnaires, teacher and student response questionnaires. This LKPD was validated by five experts consisting of a Chemistry lecturer (FMIPA UNP) and a chemistry teacher. The validation data obtained were analyzed using the v Aiken scale, while the practicality data were analyzed using a comparison of students' scores with students' maximum scores. Based on the validation questionnaire that has been analyzed, it can be concluded that the LKPD developed is valid with a v value of 0.86 with a very valid category. While the practicality of teachers and students obtained NP values of 0.85 and 0.89 with very practical categories.

## 1. Introduction

The dynamics of development in the 21st century, as well as advances in science and technology in various fields, have influenced the development of today's young generation. To organize education in the 21st century, improvements in learning need to be made. Therefore, the 2013 Curriculum is implemented which contains principles that are in line with the 21st century, and education is intended to produce generations of Indonesians who are faithful, productive, creative, inventive, and affective. Success in this digital era is highly dependent on

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Doi: <https://doi.org/10.31258/jes.7.2.p.148-159>

important skills namely 4C, critical thinking, creative thinking, communication and collaboration (Rahmawati, 2018).

The demands on each competency in the 2013 curriculum cover three domains, namely the realm of knowledge, the realm of attitudes, and the realm of skills. In addition, the 2013 curriculum aims to improve the balance, continuity and interrelationship of hard skills and soft skills (Permendikbud No. 103. 2014).

In the learning process, teaching materials are needed that are well designed and developed and pay attention to the needs of students' understanding. The teaching materials used are inseparable from the student worksheets (LKPD). Student worksheets are a great learning resource for students to use in the learning process (Astutik et al., 2017). LKPD will provide a visualization of the material being studied (Sari & Susilowibowo, 2022). Not only that, LKPD can also be used to help teachers in facilitating students to detect students' concepts through their own activities. (Hasnawati, 2021).

The STEAM (Science, Technology, Engineering, Art, and Mathematical) learning approach is one of the 21st century learning approaches related to the development of soft skills. In the STEAM Approach there are 5 fields of knowledge, so students are given an understanding of related fields holistically. The STEAM learning approach is contextual learning (Yakman, 2012). According to Buinicontrol (2018), STEAM is the integration of art disciplines into curriculum and learning in the areas of science, technology, engineering and mathematics (STEM).

The STEAM approach is a 21st century learning approach (Bayles et al., 2021). STEAM is a learning approach that allows students to broaden knowledge, science, humanities while simultaneously developing 21st century skills such as critical thinking, communication, leadership, resilience, creativity (Sibaweihl et al., 2021). Students are encouraged to explore phenomena that occur near them. The STEAM approach encourages students to learn to explore all of their abilities in their own way. Grouping students in STEAM requires personal or interpersonal responsibility during the learning process, this approach will increase students' understanding of the material being studied (Hadinugrahaningsih et al., 2017).

PjBL (Project Based Learning) is a learning model that uses a project or activity as a medium. Students carry out exploration, assessment, interpretation, synthesis and information to produce various forms of learning outcomes (Darmadi, 2017). Project-based learning is a scientific activity that involves students directly (Nasir et al., 2019). These activities can improve creative thinking skills (Suryaningsih & Nisa, 2021). The advantages of the PjBL learning model are improving study habits and stimulating students to think creatively and critically so that when faced with real-life problems students are able to overcome them (Efstratia, 2014). So based on the explanation above STEAM-PjBL is suitable to be applied in learning media in the form of LKPD. The PjBL-STEAM model allows students to learn deeper knowledge through active investigation of real-world difficulties and problems (Annisa et al., 2018). STEAM is very suitable when combined with the

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PjBL model where students who receive project-based learning have good mastery of concepts and learning outcomes (Jauhariyah, 2017). According to the Ministry of National Education (2008), LKPD can provide benefits for teachers and students in the learning process.

STEAM-PjBL integrated LKPD can be used in Chemistry learning. One of them is in the subject of Acids and Bases which is studied in class XI semester 2 at SMA. Based on the 2013 curriculum, the 2018 revision of Acids and Bases consists of four dimensions of knowledge which contain facts, concepts, principles and procedures.

As a first step in the research, interviews were conducted with teachers and questionnaires were distributed to 3 schools, namely: Padang 2 Public High School, UNP Development Laboratory High School and Batang Anai 2 Public High School. The results obtained were that the three schools used the 2013 revised 2018 Curriculum with the Discovery Learning and Guided Inquiry learning model, a scientific approach and the learning process was carried out in discussion 48%, given 6% problems, given assignments 75%, summarized material 53%, lectures 75%, assignments structured 22% and working on questions 55%. Textbooks, LKPD, Powerpoint and modules are used for teaching materials, but the LKPD used so far does not contain many pictures that interest students and students' communication skills are still low. This can be seen from the few students who ask, answer and discuss. . In the LKPD there is already 80% practicum but it is still teacher-centered and the content is still not designed for students to find and apply their own ideas and then produce a project, meaning that the existing LKPD is not yet integrated STEAM-PjBL which can develop the 4-C capabilities that become demands of the 2013 curriculum. However, in the section on Acids and Bases there are still many students who do not understand, for example on the material for calculating the pH of Acid and base solutions and the material for determining the degree of ionization of an Acid and Base solution. Based on the background above, the researcher is interested in developing Student Worksheets that are integrated with STEAM-PjBL with the aim of producing an integrated STEAM-PjBL LKPD on Acids and Bases and revealing the level of validity and practicality of integrated LKPD.

## **2. Methodology**

The subjects of this study were 3 Chemistry lecturers at FMIPA UNP, 2 Chemistry teachers and students in class XI MIPA at SMAN 2 Batang Anai. The object of this study was the STEAM-PjBL integrated LKPD on Acids and Bases for Class XI SMA. The 4-D model is a device development model suggested by Thiagarajan, Semmel, and Semmel (1974). According to Trianto (2012) the 4-D model consists of 4 stages of development, namely define, design, develop, and disseminate or adapt it to a 4-P model, namely definition, design, development, and deployment.

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### 1. Define

This stage is the stage of establishing and defining learning requirements. The definition stage aims to obtain information about the characteristics of students, problems that arise in learning, learning methods used by teachers, media used by teachers to carry out the learning process, and analyzing KD and learning materials. The define stage has 5 stages, namely front end analysis, student analysis, task analysis, concept analysis, and learning objectives analysis.

### 2. Design

At the design stage the aim is to design STEAM-PjBL integrated LKPD on Acid and Base material based on KD. LKPD which is designed according to the 2013 revised 2018 curriculum. The writing of LKPD is based on the Ministry of National Education (2008).

### 3. Develop

This stage aims to produce teaching materials in the form of STEAM-PJBL integrated worksheets which have been revised based on suggestions from validator teachers. This stage consists of three steps, namely validity test, revision and practicality test.

### **Data Type**

The type of data in this study is primary data. The primary data in question is data obtained directly from lecturers, teachers and students through interview sheets and questionnaires testing the validity and practicality.

### **Data Collection Instruments**

The instruments that will be used in this study are the first interview sheets and student questionnaires used to obtain problems faced by teachers and students in the learning process on Acids and Bases material. The data obtained is the result of the defining stage in this study. Second, for the validation test, a validation questionnaire was used and third, for practicality, teachers and students used practicality sheets.

### **Data analysis technique**

#### 1. Data analysis technique

The validity analysis technique uses Aiken's V scale which is based on categorical judgments that have been modified from Boslaugh (2008).

Using equations

$$V = \frac{\sum s}{n(c-1)} \text{ where } s = r - lo$$

Information :

s = The score set by the validator minus the lowest score used.

r = The score of the validator's choice category

lo = Lowest score in the scoring category (1)

n = Number of validators

c = Number of categories chosen by the validator

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The assessment given by the validator on the validity questionnaire is in the form of a score on the aspects that are assessed according to the criteria contained in table 1.

Table 1. Score of Validity Sheet

Answers	SS	S	KS	TS	STS
Score	5	4	3	2	1

The validity assessment criteria based on Aiken's V scale are shown in table 2.

Table 2. Decision Categories Based on Aiken's V Scale

Aiken's V scale	Category
$V < 0,8$	Invalid
$V > 0.8$	Valid

(Nugroho & Ruwanto, 2017)

## 2. Practicality Analysis Techniques

The practicality sheet assessment was obtained by distributing student response questionnaires which were analyzed using a formula that had been modified by Purwanto (2010).

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

Information :

NP = The percent value sought or expected

R = Raw score obtained from students

SM = ideal maximum score from student responses

The level of practicality of the LKPD that has been developed will be seen after being converted to table 3.

Table 3. Practicality Level Category

Value	Category
86% - 100%	Very Practical
76% - 85%	Practical
60% - 75%	Quite Practical
55% - 59%	Less Practical
$\leq 54\%$	Impractical

(Yuliawati Yunus, 2019)

## 3. Results and Discussion

This research is development research whose purpose is to produce a teaching material in the form of LKPD (Student Worksheets) that integrates the STEAM approach with the PjBL or STEAM-PjBL (Science, Technology, Engineering, Art and Mathematics – Project Based Learning) learning model in Material of Acids and Bases Class XI SMA. In conducting this research, the 4-D development model (Four D Models) was used which consisted of four stages, namely a)

Define, b) Design, c) Develop, and d) Dissimilate. This research is limited to the Develop stage. At the develop stage, the product or LKPD that has been produced will be tested for validity and practicality tests. The general description of the STEAM-PjBL integrated LKPD on Acids and Bases can be seen in Figure 1.

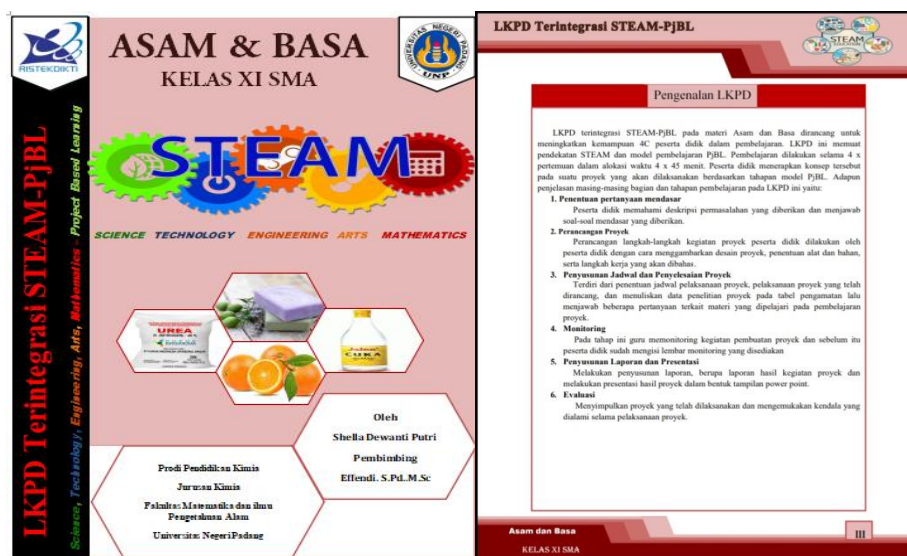


Figure 1. LKPD Development Results

## Define

### a. Front End Analysis

This analysis was carried out to reveal the underlying problems in learning chemistry in Acids and Bases which later required the development of a teaching material. This problem was obtained from the results of interviews conducted at SMA N 2 Batang Anai.

From the results of the interview, several problems were found, namely:

- Have never done a learning process using the STEAM approach with the PjBL learning model.
- The teaching materials used by the teacher are in the form of LKS and non-colored printed books.
- There is no LKPD that integrates the STEAM approach with the PjBL model which can produce projects in the teaching and learning process.

### b. Student Analysis

This analysis has the aim of identifying the learning targets in schools, namely students. From the questionnaire that was distributed to students, the following analysis results were obtained:

- Students were less interested in acid and base material
- Students are constrained in the matter of calculating acid and alkaline pH
- Students are very interested in learning using colored worksheets.

### c. Task Analysis

This analysis has the goal of identifying and analyzing what abilities students need. The task analysis is in the form of an analysis of Basic Competency (KD) and learning material. Then a GPA is formulated that is in accordance with the demands of KD 3.10 and 4.10.

### d. Concept Analysis

This analysis was carried out to identify concepts in the learning material to be taught. It begins with an analysis of the main concepts in Acids and Bases to obtain a concept map.

### e. Analysis of Learning Objectives

This analysis aims to unify the concept analysis and task analysis used in determining the behavior of objects in research. The formulation of learning objectives in Acid and Base material is through learning with the STEAM-PjBL approach and digging up information from various learning sources, simple investigations and processing information, it is expected that students can be actively involved during the teaching and learning process, have an inquisitive, thorough attitude, in making observations and being responsible for expressing opinions, answering questions, giving criticism and suggestions as well as explaining the concept of acids and bases according to Arrhenius, explaining the concepts of acids and bases according to Bronsted-Lowry, explaining the concepts of acids and bases according to Lewis, determining the properties of acids and bases by various indicators, calculating the degree of ionization ( $\alpha$ ) and the acid constant (Ka) or base constant (Kb), calculating the pH values of various solutions of strong acids, strong bases, weak acids and weak bases, analyzing the pH trajectory of a solution using indicators Summarizing the effect pH concept in everyday life.

### ***Design***

At this design stage an initial design will be produced based on the define stage. The format for writing the STEAM-PjBL integrated LKPD design is cover, preface, table of contents, introduction to LKPD, instructions for using LKPD, student identity, competencies that students must achieve (KD, GPA, and learning objectives), assignments, project instructions, as well as assessment and evaluation. LKPD is designed using Microsoft Word 2010 which is made as attractive as possible.

### ***Develop***

In the developing stage, the results obtained from the validity testing and practicality testing of the STEAM-PjBL integrated LKPD that have been produced. There are three steps in this development stage, namely as follows:

#### a. Validation

Validation is carried out to test the validity of the product produced. The LKPD validation data was obtained from three chemistry lecturers at FMIPA UNP and two chemistry teachers at SMA N 2 Batang Anai. These five experts were selected based on the opinion of Sugiyono (2014), which said that in terms of the

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validity of the instrument, it was done by expert opinion (judgment expert) with a minimum number of three people. The validation results can be seen in table 4.

Table 4. Results of LKPD Validity Data Analysis

No	Aspects Assessed	The Average Value Of V	Validity Category
1	LKPD Content Eligibility,	0.86	Valid
2	Language Component	0.86	Valid
3	Serving Components	0.86	Valid
4	Graphic Components	0.88	Valid
	<b>All Validation Components</b>	<b>0.86</b>	<b>Valid</b>

#### b. Revision

revision is an improvement of LKPD which is carried out based on suggestions and input from the validator. The part that made changes to the LKPD is described as follows

1. Changing the Competency Achievement Indicator (GPA). This change was made because the previously formulated GPA had not reached the Basic Competency (KD) demands.
2. Adding examples to the concept map section
3. Change the color of the PjBL steps
4. Make changes to the presentation of the problem and add pictures
5. Make changes to fundamental questions as a feature of the project-based learning model.
6. Changes to the project manual
7. Added monitoring section
8. Make changes to the evaluation section

#### c. Practicality

The aim is to find out whether the LKPD produced is practical or not. This practicality will be tested on 3 chemistry teachers and 25 students. The components that will be tested for practicality consist of aspects of ease of use, efficiency of learning time and benefits obtained.

##### 1. Teacher Practicality Test

The results of data analysis from practicality tests by chemistry teachers can be seen in Figure 2.

The STEAM-PjBL integrated LKPD practicality test was carried out by three chemistry teachers at SMA N 2 Batang Anai. Assessment of practicality analysis results by teachers obtained from a formula that has been modified by Purwanto (2010). From this formula, the average NP value is 85% with a very high practicality category. Thus it can be said that the STEAM-PjBL integrated LKPD on Acids and Bases is very practical to use.



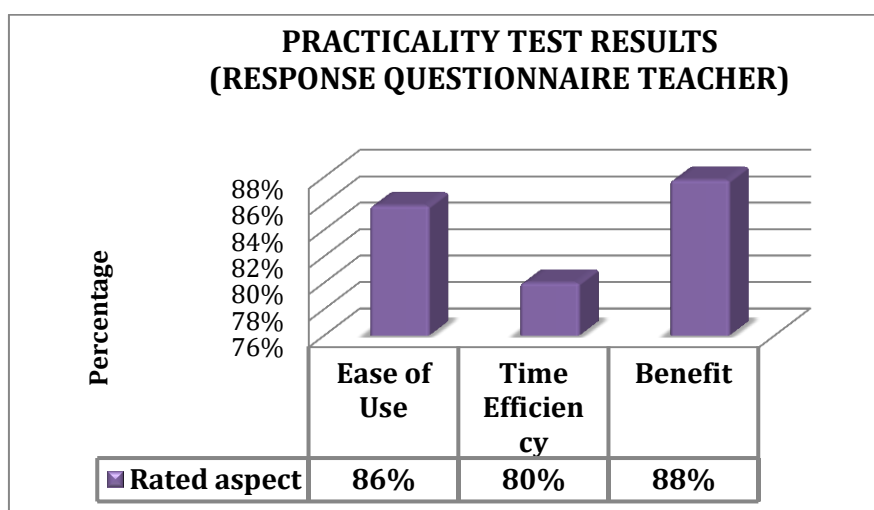


Figure 2. Graph of Teacher Practicality Test Results

In terms of the ease of use of LKPD, the practicality value is very high with a value of 86%. This shows that the instructions for using the LKPD are easy to understand and contain concise and simple material. With the use of this LKPD it is hoped that students will experience ease in the learning process because the LKPD already has clear and easy-to-understand instructions.

As for the efficiency of learning time, LKPD obtained a score of 80% in the very high practicality category. Thus it can be said that by using this LKPD learning time is more efficient. In terms of benefits, LKPD has a value of 88% with a very high practicality category. This shows that the existence of this LKPD has benefits for teachers both as facilitators and motivators.

## 2. Practicality of the Student Response Questionnaire

The results of the questionnaire analysis of student responses to the practicality of STEAM-PjBL integrated LKPD on Acids and Bases can be seen in Figure 3.

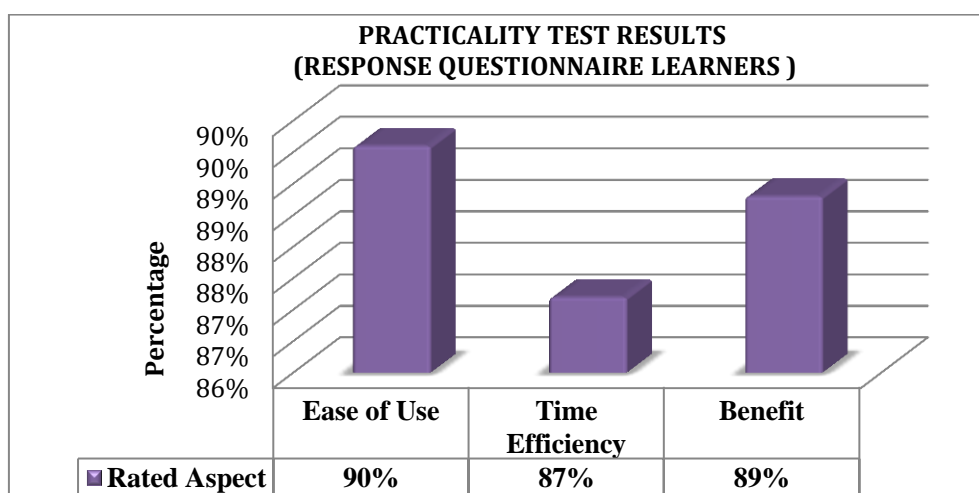


Figure 3. Graph of Teacher Practicality Test Results

LKPD practicality test was also carried out by 25 students. Students carry out the task of making a project contained in the LKPD, then fill out a practicality questionnaire given by the researcher. Practicality assessment by students on LKPD obtained an average value of 89% with a very high practicality category. Thus showing that using this LKPD can make students understand and understand the material more through STEAM-PjBL based learning.

#### **4. Conclusion**

Based on the research that has been carried out, the following conclusions have been obtained: 1) A teaching material has been developed in the form of an integrated STEAM-PjBL (Science, Technology, Engineering, Art and Mathematics-Project Based Learning) LKPD on Acids and Bases using the 4-D. 2) The LKPD that has been developed has validity and practicality categories, namely as follows: a) The level of validity by the validator with an average value of  $v$  is 0.86 with a very high validity category. b) The level of practicality by the chemistry teacher with an NP value of 0.85 is in the very high practicality category. c) The level of practicality by students with an NP value of 0.89 with a very high level of practicality category.

#### **Acknowledgement**

Thank you to Mr. Effendi S.Pd., M.Sc as the thesis advisor as well as the Academic Advisor (PA) lecturer. Drs. Iswendi, M.S. as a discussing lecturer. Mrs. Eka Yusmaita, S.Pd., M.Pd as the discussing lecturer as well as the validator. Mrs. Desy Kurniawati, S.Pd., M.Sc and Mr. Hary Sanjaya, S.Sc., M.Si as validator lecturers. Mrs. Mai Fitri Yeni, S.Pd, Mrs. Dewi Mustika Sari, S.Si, Mrs. Megawati S.Pd as a Chemistry Teacher and Validator and students in class XI IPA 2 SMA N 2 Batang Anai.

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How to cite this article:

Putri, S. D., & Effendi. (2023). Development of Steam-Pjbl Integrated LKPD on Acid and Based Materials For Class XI SMA. *Journal of Educational Sciences*, 7(2), 148-159.

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