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Development of Steam-Pjbl Integrated LKPD on Molecule Shape Materials for Class X Senior High School

Fefiola Isra Pratiwi*, Effendi

Chemistry Departement, Universitas Negeri Padang, Padang, 25131, Indonesia

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ABSTRACT

This study aims to produce STEAM-PjBL (Science, Technology, Engineering, Art and Mathematics-Project Based Learning) integrated LKPD on the material of Molecular Forms and determine the level of validity and practicality of the resulting LKPD. This research is a Research and Development (R&D) research using a 4-D model which consists of four steps: define, design, develop, disseminate. This research is limited to the design stage. The research instrument is a validity sheet and a practical sheet. The LKPD was validated by 6 validators consisting of 3 chemistry lecturers from FMIPA UNP and 3 chemistry teachers at SMA N 14 Padang. The LKPD was tested by 3 chemistry teachers and 30 students in class XI MIPA 5 SMA N 14 Padang. The validity data used the Aiken's v Scale and the practical data used a comparison of the students' scores with the maximum scores of students. The average Aiken's v scale is 0.89 with a very valid category. While the practicality of teachers and students obtained NP values of 0.90 and 0.87 with very practical categories.

1. Introduction

Molecular shape is one of the chemistry materials in the 2013 curriculum which is studied in high school in the first semester of class X. The material for molecular shape contains factual, conceptual, and procedural knowledge. This shape of the molecule requires a good illustration to think about the shape of the molecule. According to the 2013 revised 2018 curriculum, Basic Competency (KD) of this material is KD 3.6 which reads applying Valence Electron Pair theory (VSEPR) or Electron Domain theory and KD 4.6 Making models of molecular shapes using materials in the surrounding environment or software computer. Based on Basic Competency 4.6, students are able to foster creativity because they make models of molecular shapes from surrounding materials. According to Apipah et al., (2019) the process of creativity can be developed through learning chemistry in the manufacture of self-made molecular model media from various materials.

* Corresponding author.
E-mail: fefiolaisra06@gmail.com

To improve the quality of learning, a learning approach is needed that is able to support the achievement of learning objectives by students. The learning approach that is able to develop students' creativity and potential is the STEAM approach (Amran et al., 2021). STEAM learning approach (Science, Technology, Engineering, Art and Mathematics) that combines science, technology, engineering, art, and mathematics. So that students are prepared with an understanding of the interrelationships of the fields of science and knowledge (Yakman, 2012). The concept of art in STEAM can encourage students to see things from a different perspective. The addition of art and design to the 2013 curriculum provides comfort and creative thinking for students (Abdillah & Kurniawan, 2021).

STEAM will support students in project-based learning. Project-based learning activities, which are called the Project Based Learning (PjBL) model (Apriliana et al., 2018). The PjBL model is a learning strategy that strengthens students in gaining new knowledge and insights based on their experiences and invites students to carry out learning activities by producing a project (Umi, 2015). The PjBL learning model is an innovative learning model that can foster student learning motivation, foster student activity, develop student skills, develop and practice communicating in collaboration in project creation (Wahyu et al., 2016). Therefore, the PjBL model is applied to deepen the knowledge and expertise obtained by the method of making projects (Devi et al., 2019).

Based on research results Apriliana et al., (2018) learning with the STEAM approach in project-based learning is interesting, fun and fun learning. In this learning, students are able to develop students soft skills, namely cooperation, critical thinking, caring for the environment, responsibility, adaptability, and honesty. Therefore, the STEAM-PjBL model can be applied to train students to build their creativity.

To apply the STEAM-based PjBL learning model, it will be maximized with teaching materials, one of which is LKPD. LKPD is a student guide that is used in investigations and problem solving in learning as well as in the form of exercises to achieve competency (Aini et al., 2019). LKPD is able to support the learning process to build optimal interaction between teachers and students in the learning process so that it will result in increased learning and student learning outcomes (Tukan et al., 2020). Based on research Herlina & Hasri (2021) it was found that the use of STEAM-based e-modules and e-LKPD on colloidal system material was effective in increasing learning outcomes with a completeness percentage of 84.85%. STEAM-PjBL integrated worksheets are expected to help students discover and consolidate concepts in learning molecular shapes.

As a first step in this study, the authors made observations at SMAN 14 Padang in the form of interviews and questionnaires. This questionnaire was given to students of class XI SMA and interviewed chemistry teachers. From the results of teacher interviews, information was obtained that the model used in learning Molecular Forms was Discover Learning. The method used in learning is lecture and question and answer. It can be seen that the school has never used the

STEAM approach and also the PjBL learning model with project activities that guide students in strengthening concepts.

From the questionnaire filled out by students, it was found that as many as 75% of students were interested in the material of Molecular Forms. This percentage illustrates that Molecular Shapes material is interesting to study. However, as many as 62.5% of students did not understand the material in the electron domain theory section. The teacher's efforts have used teaching materials in the form of 60% of students stating that they used printed books from publishers, 45% used worksheets, 60% modules, and 15% used PPT. As many as 85% of students think that LKPD is able to help in understanding the material. In addition, the teaching materials used are in the form of textbooks, LKPD and simple modules made by school teachers. However, the LKPD used is not in accordance with the 2013 curriculum which guides students to be actively involved. The LKPD used has not used the learning syntax that is in accordance with the learning model. As for KD 4.6 which guides students to design a project to make molecular shapes from surrounding materials it is not carried out so it does not lead to students' creative attitudes, critical thinking, collaboration and communication. Previously several studies had been developed, however, in the form of STEM including the development of LKPD on Thermochemistry material by Syafe'I & Effendi (2020), and Electrolyte and Non Electrolyte Solutions by Firmansyah & Effendi (2021). Based on previous research, a renewal was carried out by adding elements of art to the development of this LKPD.

Based on the background above, the authors conducted a study to produce Student Worksheets (LKPD) integrated with STEAM-PjBL (Science, Technology, Engineering, Arts, and Mathematics- Project Based Learning) on the Material of Molecular Forms for Class X High School and revealed the level of validity and the practicality of LKPD as teaching materials in chemistry learning.

2. Methodology

The type of research used is Research and Development (R&D) with a 4-D development model which has four stages, define, design, develop, and disseminate (Thiagrajan et al., 1974). However, this research is limited to the develop stage. This study aims to produce a product in the form of STEAM-PjBL integrated worksheet on molecular shape material.

Research subject

The subjects of this study were three Chemistry lecturers at FMIPA UNP, 3 Chemistry teachers and students in class XI MIPA SMA N 14 Padang.

Research Procedure

1. Define

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 analyze Basic Competency (KD) and

learning materials based on the curriculum syllabus. It consists of 5 stages, namely: front end analysis, student analysis, task analysis, concept analysis, and learning objectives analysis.

2. Design

The goal at this stage is to prepare the STEAM-PjBL integrated LKPD on Molecular Form material which will be designed according to Basic Competency (KD) as well as material that has been analyzed at the define stage. LKPD writing is based on Depdiknas (2008).

3. Develop

At this stage the aim is to produce an integrated STEAM-PjBL LKPD on the revised Molecular Form material on the advice of the validators. At this stage the validity test and practicality test were carried out.

Data Collection Instruments

The instruments used in this study were validity and practicality questionnaires. The validity questionnaire was given to UNP chemistry lecturers and chemistry teachers at SMAN 14 Padang. The validity questionnaire is used to assess the developed LKPD, then it is revised according to the suggestions given by the validator. After the revision, a practicality test of the LKPD was carried out to find out the practicality of using the LKPD that was developed.

Data analysis technique

1. Validity analysis technique

Validation analysis uses Aiken's scale with the formula in Equation 1. With the validity category contained in the Table 1.

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

Information:

- V = Aiken V which shows product validity
- c = The score given by the highest validator
- r = The score given by the validator
- n = multiple validators

Table 1. Category Validity Criteria

No	Aiken V scale	Validity
1	$V \leq 0,8$	Non Valid
2	$V \geq 0,8$	Valid

(Aiken, 1985)

2. Practicality analysis technique

The results of the practicality assessment were obtained from a questionnaire given to teachers and students, after which the results obtained were analyzed using a modified formula Purwanto (2009) on the Equation 2.

$$NP = \frac{R}{SM} \times 100 \% \quad (2)$$

Information:

NP = Expected percent value

R = Raw score obtained

SM = The ideal maximum score of the test

The practical level of the developed LKPD will be seen after being converted to the category Table 2.

Table 2. Practicality Criteria

No	Score	Rated aspect
1	86%-1 00%	Very Practical
2	76%-85%	Practical
3	60%-7 5%	Practical Enough
4	55 %-59%	Less Practical
5	≤54 %	Impractical

3. Results and Discussion

This research produced teaching materials in the form of STEAM-PjBL integrated LKPD on the material of Molecular Forms. The type of research used Research and Development (R&D) with a 4-D model which consists of 4 stages that is define, design, develop, disseminate. However, it is limited to the Develop stage. The three stages are described below:

1. Define Stage

- a. Front End Analysis. Analysis to find problems with interviews with chemistry teachers and filling out questionnaires by class XI MIPA students at SMAN 14 Padang. From this, the problems are: 1) Some students have difficulty understanding molecular shape material because it is abstract and students are new to chemistry in high school, 2) In the implementation of learning on Molecular Forms the approach used is scientific and the STEAM approach has never been applied (Science, Technology, Engineering, Arts, and Mathematics), 3) The learning model used is discovery learning. There is no implementation of the PjBL model (*Project Based Learning*), 4) The non-implementation of Basic Competence in Molecular Shape psychomotor, namely the making of Molecular Shape models from the surrounding material, 5) The LKPD used a structured form in accordance with the 2013 curriculum and is not in accordance with the learning model used in the Molecular Forms material.
- b. Student Analysis. Aims to analyze the characteristics of students. From the results of distributing the questionnaire, the results were 1) As many as 75% of students liked the material in the form of molecules because it was interesting, but 50% of students did not understand the Valence Electron Pair Theory (VSEPR), 2) 85% of students considered using worksheets in learning to be able to help students 3) There is no enthusiasm for students in learning because the

learning method used is lectures. Based on the questionnaire analysis to improve the quality of learning, teaching materials are needed in the form of worksheets that are able to attract the interest and enthusiasm of students in learning and develop students' creativity (Latifah, 2016).

- c. **Task Analysis.** This analysis was carried out to find out the contents of the learning unit which includes, Competency Achievement Indicators (IPK), learning objectives, concepts and sources of information (Lestari et al., 2018). This analysis is carried out by analyzing Basic Competency (KD), then it becomes IPK (Competency Achievement Indicator), as well as learning objectives that must be achieved by students. The basic competencies in molecular shape material are as follows: 3.6 Applying Valence Electron Shell Pair Theory (VSEPR) or Electron Domain Theory in determining molecular shapes and modeling molecular shapes using materials available in the surrounding environment or software. The Basic Competency describes several indicators of competency achievement, namely: 1) Determining the number of bonding electron domains and free electron domains of a molecule, 2) Explaining the theory of VSEPR or bonding electron domains, 3) Designing and modeling the shape of a molecule using existing materials around, and 4) Designing and modeling molecular shapes using materials that are around. Based on basic competencies and competency achievement indicators, molecular form worksheets are designed according to task analysis, so that students are able to achieve the competencies that have been applied during the learning process.
 - d. **Concept Analysis.** This is done by identifying the main concepts to be taught and arranging them systematically according to the order of presentation and details of relevant concepts. At this stage it produces, 1) Analysis of the material obtained based on the dimensions of knowledge in the form of facts, concepts, principles, and procedures, 2) Concept analysis, which consists of concept labels, concept definitions, concept attributes, concept hierarchies, types of concepts, examples, and non-examples to form a concept analysis.
 - e. **Analysis of Learning Objectives.** Learning objectives are arranged based on indicators of competency achievement. The learning objectives that have been formulated in the material of Molecular Forms through the STEAM approach with the PjBL learning model integrated into STEAM-PjBL by digging up information from various learning sources, simple investigations, and processing information, it is hoped that students will be actively involved during the learning process, have an attitude of wanting to know, be thorough in making observations, and be responsible in expressing opinions, answering questions, giving suggestions and criticisms and achieving the expected IPK.
2. **Design Stage.** This stage aims to design the LKPD that will be produced. The format for writing the initial draft of the STEAM-PjBL integrated LKPD is sourced from the teaching material development guidebook, namely cover, supporting pages (preface, table of contents, introduction to LKPD, instructions for using LKPD, student identity), competencies to be achieved (KI, KD, GPA
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,and Learning Objectives), assignment and project instructions, assessment, and evaluation. Making LKPD is made using Canva, and Microsoft Word 2016.

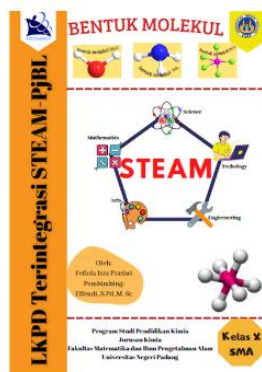


Figure 1. Cover

3. Develop Stage.

- a. Validity Test. Validity is one of the stages of research and development carried out to assess the validity of the product produced. Selection of the validator for a product can use expert judgment with a minimum of 3 people (Sugiyono, 2013). Determination of validity was carried out by 6 validators consisting of 3 chemistry lecturers at FMIPA UNP and 3 chemistry teachers at SMA N 14 Padang.

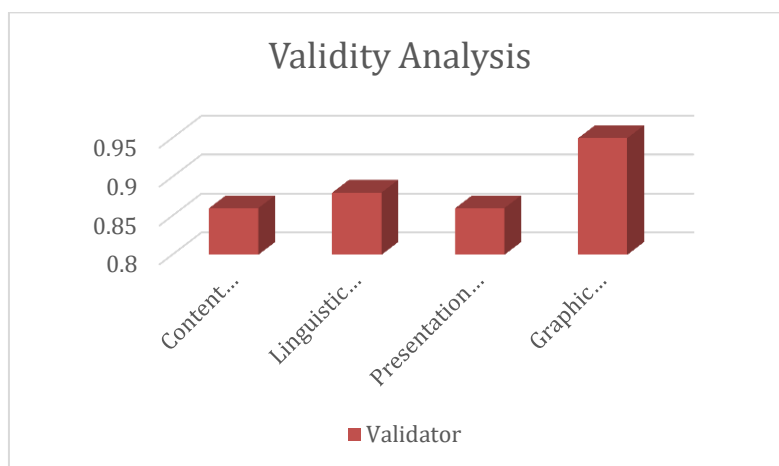


Figure 2. The Results of The Validation Data Analysis are 6 Validators

The content feasibility component has an average value of Aiken's scale of 0.86 with valid criteria. This assessment explains the suitability of the developed LKPD which has presented Molecular Form material in accordance with the demands of the 2013 revised 2018 curriculum on core competencies and basic competencies. Teaching materials developed must be in accordance with the applicable curriculum (Depdiknas, 2008). The suitability of the content in terms of feasibility is seen based on the learning model in developing, questions, and

exercises that are compatible with the model used, namely the PjBL (Project Based Learning) model. In addition, the developed LKPD is also in accordance with the indicators and learning objectives to be achieved.

The linguistic component of the STEAM-PjBL integrated LKPD in the Molecule Shape material developed has an average value on Aiken's scale of 0.88 with a valid category. The level of validity is obtained because the language used in the preparation of LKPD uses good and correct language according to Indonesian grammar rules. The aspects of the assessment of the linguistic component according to Depdiknas (2008) includes: legible forms and letters, clarity of information, compliance with good and correct Indonesian language rules and using clear sentences and not causing confusion so that the instructions and information contained in the LKPD can be understood.

The presentation component of the developed LKPD gets an Aiken's scale value of 0.86 with a valid category. This shows that the LKPD has been successfully prepared in accordance with the GPA and the order in which the material is presented based on the Project Based Learning (PjBL) model which is composed of: (1) basic questions (2) project design (3) scheduling (4) monitoring project progress (5) assessment results (6) evaluation (Al-Tabany, 2014). The preparation of LKPD is also arranged based on the systematic components of LKPD preparation, starting from the title, instructions for use for students, competencies to be achieved, supporting information, and tasks and work steps (Depdiknas, 2008).

The graphic component is another important assessment of the product being developed. This is because the layout of the preparation of teaching materials and good colors can support students' memory in learning (Sujarwo & Oktaviana, 2017). This LKPD has a graphic value with Aiken's scale of 0.95 with a valid category. This stated that the layout, type and size of letters, image clarity, and color selection were considered attractive overall. Revision. This stage is carried out with the aim of improving the STEAM-PjBL integrated LKPD section on the Molecular Form material which is considered inappropriate by the validator before the product is tested. Some of the revised parts of the LKPD are: 1) Writing compound formulas according to chemical rules, 2) Correcting some typos, such as Lewis, Essential, 3) Correcting reading about chemistry by associating it with clear sources, 4) Correcting GPA by dividing the GPA sections support, key GPA, and enrichment GPA, 5) Make questions to find projects to be carried out, 6) Improve the evaluation section to eliminate conclusions.

b. Practicality. Teaching materials are said to be practical if the teaching materials can be measured in terms of ease and presentation by students, both in terms of cost, time, and do not cause problems in learning (Agustyaningrum & Gusmania, 2017). Figure 3 below shows a diagram of the results of the LKPD practicality analysis that has been used by students.

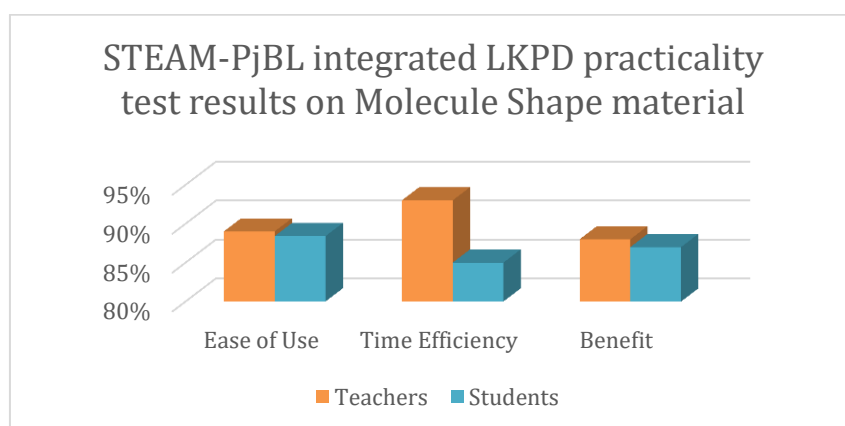


Figure 3. LKPD practicality analysis data

Based on the ease of use of the integrated STEAM-PjBL LKPD on the Molecular Form material from the teacher and student assessments in the high category and the score obtained was 89% from the teacher and 88.4% from the students. This indicates that the LKPD being developed is easy for teachers and students to understand and understand because this LKPD uses communicative language and clear learning steps in accordance with the Project Based Learning learning model and uses the Science, Technology, Engineering, Arts, and Mathematics (STEAM).

In terms of time efficiency, it has an average value resulting from the teacher's questionnaire of 93% and 85% of the students' questionnaire in the high category. The worksheets contained in the LKPD aim to arouse and assist students in carrying out the learning process to master understanding, find concepts, skills, and produce a project. The teaching materials developed are able to help the implementation of learning to be more effective and efficient in achieving the learning objectives that have been set (Pane & Dasopang, 2017).

The benefit aspect gets an average response score of 88% from teachers and 87% from students in the high category. This shows that the STEAM-PjBL integrated LKPD on Molecular Form material has the benefit of being able to assist teachers in implementing learning. In addition, LKPD also makes it easier for students to understand molecular shape material, resulting in a project for making molecular shapes, and makes students active in communicating, and solving problems in groups. One of the benefits for teachers is to increase the role of the teacher as a facilitator. In this LKPD is able to monitor and assess the performance of students in groups and obtain information about students' understanding through the activeness of students in the learning process. Other benefits obtained by students are being able to help students to collaborate, communicate with each other, increase creativity, and critical thinking skills.

4. Conclusion

Based on the research that has been carried out, the STEAM-PjBL integrated LKPD has been produced on molecular shape material with a 4-D development

model and the results have been tested for validity and practicality. Based on the analysis of validity data, it was found that LKPD in terms of content feasibility, language components, presentation components and graphical components were said to be valid. The practicality test from the data analysis of students and teachers stated that the results were very practical.

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