

# The Development of Worksheet Integrated Learning Material With Project-Based Learning Model on Molecule Shape Topic (For Chemistry Bonding Course)

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## ABSTRACT

The important role of teaching materials in learning activities is very restricted due to the available learning materials were not optimal in providing the appropriate material and method for students. The development of learning material is needed to provide students with appropriate learning material in helping to improve knowledge. This research was aimed to know the feasibility of learning materials which were used by students based on National Education Standard Agency of Indonesia (BSNP), to know the feasibility of developed learning material, to know learning outcome and student response. The research was carried out by following research and development method of ADDIE. Samples in this research were two learning materials that used by student and one experimental group of 28 students who were studying molecule shape topic at Universitas Negeri Medan. The research results shows that the feasibility of chemistry learning materials that used by student was proper to use based on the analysis but there were still some weaknesses that need to be revised and developed. The standardization result of the developed learning material from validator was valid and no need to be revised. The Student learning outcome was higher than standard of minimum competency after used the developed learning material and Student perception to the use of the developed learning material was good.

**Keywords:** Learning material, worksheet, Molecule Geometry, Chemistry bonding, Project-based learning

## 1. INTRODUCTION

In education, products which are produced through research and Development (R&D) is expected to increase productivity of education, i.e. a large number of graduates, qualified, relevant with the needs [1]. Learning material is one of education product which may be produced through research and development method. Today, the important role of the used learning material in learning activity is very restricted due to the available learning materials are still have weakness, so that it become less helpful in learning [2]. A lot of already used textbooks just gives out learning material with no provides opportunity to students for investigating and lecturer uses it as a dominant learning tool in science education [3]. Based on earlier observation had been carried out on Department of Chemistry Education at

State University of Medan is known that students in chemistry bonding course were still using the old learning material. It's caused there's no newest edition of learning material that was published for the course. The students still using learning resource that have not been developed in accordance with the current curriculum. In addition, in the learning process students still relied on books, learning media in the form of powerpoint slides from lecturers as a learning resource which generally targets a rote learning.

According to previous research is known that learning method which is brought about conventionally and the use of unattractive learning material presents an unsatisfied learning outcome [4]. Therefore, the development of chemistry learning material is crucial due to it motivates students to acquire the desired knowledge and ability [5]. A good quality of learning material helps

student to understand chemistry concepts, while illustration in learning material makes them easily understood and to facilitate students to understand correlation between theory and reality [6]. The effort can be carried out to make effective learning activity is by means of the use of attractive learning material through the development of worksheet integrated learning material. Worksheet is known to help students gain scientific process abilities such as conducting experimental mechanisms, recording data, interpreting data, and so on, so that students can make concepts in their minds [7]. Worksheet is defined as important learning media because they can determine what students need to do, help build information with their own thoughts independently and at the same time make them participate in activities provided by lecturers [8]. In addition, the use of worksheets proved to be effective and had a positive effect on learning activities, based on obtained cognitive learning results [9,10].

The another effort that can be made in the innovation of worksheet integrated learning materials is through the application of learning models. One of learning model that can be applied is the PjBL (Project-Based Learning) model. PjBL model is an active learning method that aims to engage students in gaining knowledge and abilities through the real world experience and well planned activities [11]. Based on research data has been done, it is known that when project-based learning method was applied, student achievement increases higher than students who were taught using traditional learning method. Based on qualitative data from the research, it can also be observed that students give positive opinions about the used method [12].

Molecule shape is one of the subjects studied in chemistry bonding course. It is an important subject in understanding chemical compounds correctly because this subject has an important role in determining the physical and chemical properties of a molecule [13]. Strategies in learning of molecule shape is needed to make students interested in learning it. One of strategies that can be done is to develop teaching materials. The aim of this study is to produce worksheet integrated learning material with PjBL learning model for chemical bonding course on molecule shape topic that can be used as learning materials to meet the achievement of student's cognitive learning outcome.

## 2. METHOD

### 2.1 Research Procedures

This study was designed to develop a worksheet integrated learning material with PjBL model for chemistry bonding course on molecule shape topic by following Research and Development (R&D) of ADDIE research model that has successfully been carried out by another's research [14-16]. The study was carried out at

Department of Chemistry Education, Faculty of Mathematics and Natural Sciences (FMIPA), with five steps: (1) Analysis, (2) Design, (3) Development, (4) Implementation, (5) Evaluation.

The developed learning material was evaluated by using sheet of standar assessment to meet the required criteria by BSNP. Learning outcome's test instrument in the form of objective test questions which was used to measure the effectiveness of the developed learning material in terms of students' ability to answer objective test questions. The perception questionnaire instrument was used to obtain data about students' responses to the developed teaching material that had been used during learning activities.

### 2.2 Development and Standardization of Learning Material

The development of learning material was carried out by enriching the topic of molecule shape for chemistry bonding course in order to meet the competencies that must be achieved by students determined by the curriculum applied at the department of chemistry education, followed by the integration of worksheet with project-based learning model, preparation of relevant learning media and providing hyperlinks to selected and trusted websites that are related to the topic of molecule shape. Then, tasks with specific instructions are completed in the teaching material package. The learning materials had been developed were evaluated by three expert validators and its eligibility was assessed using a standard questionnaire to meet the book's eligibility criteria according to BSNP. Furthermore, the learning material was provided in form of printed learning material.

### 2.3 Implementation of Learning Material

The implementation was conducted in one group of experimental class. The developed learning material was used as a main learning resource for the group. Before the treatment, the group was given a pretest. The Students in the experimental class were asked to learn molecule shape using the developed learning material for chemistry bonding course, work on worksheet as discussion material in study groups, and do routine assignments as independent assignments. Posttest was given to the experimental class at the end of the meeting. Furthermore, the students fill out the questionnaire on perception to find out their responses regarding the developed learning material.

## 3. RESULT AND DISCUSSION

### 3.1 Development of Learning Material

The Development of teaching materials has been carried out through the procedures of ADDIE research model. The development step is based on the analysis

step result by enriching of the contents of chemical materials which are complemented by several analogies of learning topic through examples related to daily life, integration of project-based learning models, important concepts needs to remember, examples of problem, short stories of chemistry figures, some questions as routine tasks, and review of all molecular shape topic in worksheets arranged systematically based on the steps of the PjBL model.

The provided material in the learning material is outlined into three learning activities, namely: 1) Learning activity I describes the introduction of molecular shape topic ; 2) Learning activity II describes the theory of Valence Shell Electron Pair Repulsion (VSEPR); 3) Learning activity III describes about the concept of hybridization. The components in the worksheet integrated learning material with PjBL model for chemistry bonding course on molecule shape is summarized in table 1.

### 3.2 Standardization of Learning Material

Standardization of the developed learning material was assessed in accordance with four of feasibility standards based on BSNP that is content, language, presentation, and graphic. The developed learning material was analyzed by three of expert validators who are active lecturer in department of chemistry education by filling a validation instrument of learning material which had been prepared by reasearcher. The developed learning material has met the required criteria given by BSNP from the result of standardization had been conducted in which it is assigned to be very good ( average score is 3.5). It means that the integrated-worksheet learning material with PjBL model is suitable for teaching of molecule shape on chemistry bonding course. The feasibility level of developed learning material is shown in figure 1.

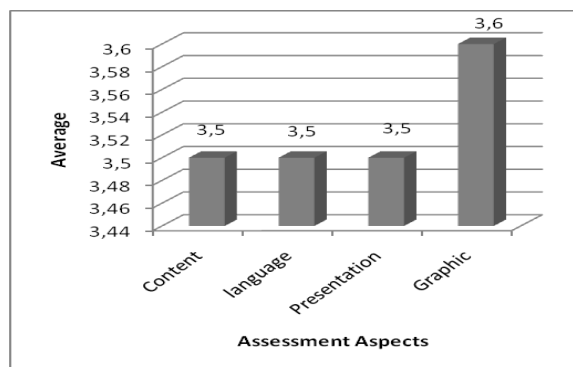


Fig. 1. The graph of feasibility analysis of integrated worksheet learning material with pjbl model for chemistry bonding course on molecule shape topic.

Table 1. The components in the developed learning material

Components	Descriptions of The Developed Learning Material on Molecule Shape Topic
Concept Map	Equipped with concept map of molecule shape topic to illustrate important concepts and to relate among the concepts in the molecule shape topic
Introduction	It is consists of basic competencies, learning outcomes, coverage of teaching material materials, prerequisites, learning models, instructional media, and instructions for the use of learning material
The Introduction of Molecule Shape Topic	Enrichment of learning material, the history of the development of molecular shape determination, biographies of chemical figures
The Theory of VSEPR	Enrichment of learning material, histories of VSEPR theory, integration of analogies in daily life in explanation of VSEPR theory, tables of several molecule geometries based on VSEPR theory, examples of problems regarding the determination of the number of electron groups, electron domain geometry, VSEPR notation, and molecular geometry, and integration of molecule images with divalent, trivalent, tetravalent, pentavalent, hexavalent, and images explanatory of the effects of double bonds and free electron pairs on the shape of molecules
Simulation of Molecule Shape	Integration of chemsketch to simulate the molecule shape and the using steps
Hibridization Concept	Topic enrichment, strengths and weaknesses of the VSEPR theory and the concept of hybridization, examples of problems about molecules from overlapping original orbitals and hybrid orbitals, tables of several molecule geometries based on the molecule hybridization
Summary	Equipped with conclusion of the molecule geometry topic

Worksheet	There is worksheet with PjBL model and project task as student's task in learning group
Exercise Task	There isi exercise task as student's routine task
Bibliography	Equipped with bibliography of some reading sources used by author
Glossary	Equipped with glossary arranged alphabetically
Periodic System of Elements	Equipped with Periodic System of Elements
Answer Keys	Equipped with the answer key of routine task

The analysis result of the developed learning material based on BSNP questionnaire had been modified i.e. 1) the content feasibility with average of 3.5 which means valid and not need to be revised; 2) the language feasibility with average of 3.5 which means valid and not need to be revised; 3) the presentation feasibility with average of 3.5 which means valid and not need to be revised; 4) the graphic feasibility with average of 3.6 which means valid and not need to be revised.

### 3.3 Implementation of Learning Material

Worksheet integrated learning material with project-based learning model have been implemented in the classroom to learn the topic of molecule shape on chemistry bonding course in third semester of chemistry education major. Student's learning outcome was obtained from the ability of students to do the pretest and posttest. It is summarized in Table II.

Based on the results of the analysis using the Chi-square analysis technique, the obtained data in the experimental class were normally distributed. Based on Table II shows that the N-gain (level of student's understand) on the topic of molecule shape is obtained an average of 0.7 (it's categorized high).

The effectiveness of learning material is analyzed in accordance with the value of learning outcome in the posttest which was analyzed using one sample t test. Learning outcome show that the posttest is higher than the pretest score. According to the results of the hypothesis test shows that student's learning outcomes who were taught with developed learning material is higher than the minimum of competency standards. It can be said that the acquisition of student's learning outcomes is caused by the use of worksheet integrated learning material with the PjBL model. Thus, the developed learning material proved to be effectively used

for learning on the topic of molecule shape for chemistry bonding course.

The results of student perceptions to worksheet integrated learning material with the PjBL model on the topic of molecule shape for chemistry bonding course is can be seen in Table III.

**Table 2.** Student's learning outcome based on pretest and posttest on molecule geometry topic.

Class	Evaluation test			
	Pretest		Posttest	
Eks	Average score	Normality	Average score	Normality
	51,78	5,14	85	10,37
N-gain	0,7			

**Table 3.** The student's perceptions to the integrated worksheet learning material on molecular geometry topic for chemistry bonding course

NO	Indicators	Percentage of student	Explanation
1	I am pleased with the subject matter of molecule shape topic that has just been implemented (ie learning using worksheet integrated learning material with project-based learning model.	85%	Very good
2	The used worksheet integrated learning material describes the concept of discussed molecule shape topic.	81%	Very good
3	I interests to the learning of molecule shape with the worksheet integrated learning material with project-based learning model.	84%	Very good
4	I actively learn and participate in the learning of molecule shape (ie a learning with worksheet integrated learning material with	75%	Good

	project-based learning model.		
5	I easier to understand the subject matter of molecule shape with worksheet integrated learning material with project-based learning model.	79%	Good
6	Project-based learning provoke my curiosity.	84%	Very good
7	Learning with the project-based learning model encourages me to always ask about problems that I have not been able to solve.	81%	Very good
8	Learning with worksheet integrated learning material with project-based learning model encourages me to innovate more.	79%	Good
9	Learning with worksheet integrated learning material with project-based learning model encourages me to be more creative.	79%	Good
10	In every learning, I want the learning process to use worksheet integrated learning material with project-based learning model.	76%	Good

The results of responses from 28 students in the experimental class to the using of developed learning material in learning is classified good with an average percent of 80%. It can be said that students' perceptions are positive during learning activities using the developed learning material [17-18].

Worksheet is defined as important learning media because they can determine what students need to do, help build information with their own thoughts independently and at the same time make them participate in activities provided by lecturers [8]. The project-based learning is proved to be effective in helping students to obtain the completeness in learning and gives a positive perception about the learning method [12].

#### 4. CONCLUSION

The worksheet integrated learning material with project-based learning model on molecule shape topic for chemistry bonding course had successful been developed. The standardization result of the developed learning material by three validators indicates that the learning material had met the required criteria by BSNP. The implementation of the developed learning material in learning activity shows that it was effective to be used in learning activity, it can be seen from the student's average learning outcome was higher than the minimum of competency standards. In addition, the students gave positive perception to the developed learning material. It is suggested to apply the development for the others chemistry topics in order to obtain a better learning outcome.

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