Student responses toward worksheets based on STEM approach through project-based learning model

M Syukri¹, S Maghfirah¹, A Halim¹ and F Herliana¹
¹ Department of Physics Education, Universitas Syiah Kuala, Jl. Teuku Nyak Arief, Darussalam, Banda Aceh, Indonesia, 23111

Abstract. This study aims to determine student responses toward student worksheets based on the STEM approach through the PjBL model. The study was conducted on students of Class XI Science 4 at SMA Negeri 5 in Banda Aceh involving 27 students. The research method of the study used descriptive research which described student responses toward student worksheets based on the STEM approach through the PjBL model that has been previously developed. The data collection techniques utilized the student's response questionnaire consisted of 10 statements and arranged using four alternative answers. The data processing of the research results used a Likert scale. Based on the result, the study obtained an average percentage of student responses of 85.09% with very good criteria. It showed that the students gave a positive response to student worksheets based on the STEM approach through the PjBL model.

Keywords: Student Responses, PjBL, STEM

1. Introduction
Through the efforts to improve the quality of human resources, education may enhance the quality of national life. As explained in law number 20 of 2003, i.e. Education is a conscious and planned effort to create an atmosphere of learning and learning process so that the students actively develop their potential to have the spiritual strength, self-control, personality, intelligence, noble morals, and skills needed by themselves, society, nation, and state. Based on the results of preliminary observations conducted at several schools in Banda Aceh, it was known that physics teachers often teach using conventional methods or lectures. As a consequence, the students become less active in the learning process because it only goes to one way where the students just record what is conveyed by the teacher. Teachers should be able to make students experience learning that is interactive, inspiring, fun, and motivates students to be able to actively participate in learning. So that in carrying out their duties teachers are required to be able to understand and have skills in developing various learning models that are in accordance with the curriculum to be able to help students be more active in learning [1].

According to the Minister of Education and Culture regulation number 65 of 2013 concerning the standard process, it is known that one of the learning model which is accordance with a scientific approach that is the implementation of 2013 curriculum by using Project Based Learning model (PjBL) [2]. The PjBL is a learning model based on a project where the students can get the knowledge independently and meaningful learning experiences through the process of producing products to complete the given project task [3] [4] [5]. There are 6 stages of implementing the PjBL model in learning, namely [5]:

[1] [2] [3] [4] [5]
1) Start with the essential questions, at this stage learning begins with questions that can assign students to carry out an activity.
2) Design a plan for the project, students and teachers collaboratively carry out planning which contains rules, selecting activities that can support in answering fundamental questions by knowing the tools and materials and working steps.
3) Create a schedule, students and teachers collaboratively arrange a schedule of activities in completing a project such as creating a timeline for completing the project.
4) Monitoring students and project progress, the teacher is responsible for monitoring the activities of students during the completion of the project and the teacher is also a mentor for student activities.
5) Assess the outcome, at this stage students test the project that has been completed and the teacher assesses the project given.
6) Evaluate the experience, at this stage students and teachers discuss to improve performance during the learning process so that in the end they can find new findings to answer the problems raised in the first stage of learning.

The project based learning model has various advantages as follows; This model is in accordance with the curriculum applied in Indonesia so that in its implementation there is no need for anything additional, students are actively involved in real-world activities and can practice authentic strategies in a disciplined manner, students work collaboratively in solving problems that are important to them, can find new technologies, and improve teacher cooperation in designing and implementing projects [6]. Getting into the 21st century, technological and communication advancements have influenced human lifestyles towards how to communicate, work, and even study. Technological advances in education require teachers and students to have suitable teaching and learning abilities in the 21st century. One of the approaches in learning which is appropriate for the 21st century is a STEM approach. It is an interdisciplinary approach in learning where the students apply science, technology, engineering, mathematics in the real contexts which can connect among the world of school, work, and student global [5, 7].

There are four fields of knowledge in the STEM approach, namely Science, technology, engineering, and mathematics. Each field of science has a different role. The role of each field of science is as follows [9]:

1. Science is knowledge accumulated over time and can produce new knowledge through a process of scientific investigation. Knowledge from science plays a role in providing information in the engineering design process.
2. Technology consists of the entire system of people and organizations, knowledge, processes, and devices that create objects and then operate them. Most of modern technology is a product of science and engineering.
3. Engineering is a collection of knowledge about the design and creation of man-made products, as well as a process for solving problems. Engineering uses science and mathematics as concepts and technology as tools.
4. Mathematics is a pattern and relationship between numbers, numbers and space. Mathematics is used in science, technology, and engineering.

The STEM approach can also encourage students to be more active in learning. As the goal of STEM so that students can have scientific and technological literacy skills that can be obtained from reading, writing, observing, and carrying out direct scientific activities so that if they face problems related to the STEM field of science in their daily life they can develop competencies which he has had [10]. Engineering Design Process (EDP) is one of the things that cannot be separated from STEM. Engineering Design Process is a process that can train students' ability to solve problems related to the real world. There are 5 stages in the engineering design process, namely [11, 12]:

1) Ask, at this stage students explore problems and find ways to make their best products based on scientific concepts that have been learned.
2) Imagine, at this stage students must think and imagine products to solve problems.
3) Plan, at this stage students design possible solutions in the form of a diagram they imagined in the previous activity.
4) Create, at this stage students develop scientific technical products into the form of plans they have made to solve problems.
5) Improve, at this stage students make improvements to the technical science products they have developed based on the weaknesses and deficiencies identified by teachers and students in other groups.

PjBL and STEM is a complementary approach and learning model. Applying the PjBL model for creating a product, the students can comprehend the learning materials. Meanwhile, in the STEM approach, the students conduct the steps of the engineering design process that may help to produce the product based on the given project [13]. There are two main parties involved in the learning process carried out in a class namely the teacher and student. To produce a good learning activity, it needs good interaction between teacher and student in the teaching and learning activities. The interaction can be in the form of responses given by the students to the learning applied by the teacher in teaching and learning activities. The response is a reaction in the form of acceptance, rejection, or an indifferent attitude to what is conveyed by the communicator in the message [14]. The formation of responses is needed in the learning activities. It will generate changes in behavior based on experiences [15]. Learning is the interaction between stimulus and response. It requires input in the form of stimulus and output in the form of response [16]. The stimulus which is provided in this study is student worksheets based on the STEM approach through the PjBL model and the output in the form of the student responses to the positive response to student worksheets based on the STEM approach through the PjBL model. The purpose of this study is to determine the student responses toward student worksheets based on the STEM approach through the PjBL model.

2. Method
This study used descriptive research. It described student responses toward student worksheets based on the STEM approach through the PjBL model that has been previously developed. Thus, the object in this study was students’ responses to student worksheets based on the STEM approach by way of the PjBL model applied in the learning. This study was conducted at SMAN 5 Banda Aceh involving 27 students of class XI Science 4 as the respondents. Besides, the object of the study was chosen based on the students’ consideration which was they have not carried out the learning using student worksheets based on the STEM approach through the PjBL model yet. At the same time, the material used in this study was optical devices. Furthermore, the instrument used in this study was a questionnaire of students’ responses toward student worksheets based on STEM through the PjBL model arranged by four alternative answers such as strongly disagree, disagree, agree, and strongly agree. In analyzing the data, the step used was to change the qualitative data into quantitative by using the Likert scale provisions.

3. Result and Discussion
Before seeing the student's response, first learning is carried out using STEM-based learning tools through the PjBL model. In this lesson, students are given a LKPD which includes EDP steps as a characteristic of STEM and the teacher leads the lesson according to the stages in the PjBL model. The material taught is an optical instrument with the project of making a simple periscope that can look up and down (Figure 1). Student’s responses were obtained by questionnaire consisted of 10 statements. The questionnaire was given to the students after treatment by using the learning based on STEM through the PjBL model on optical devices. Table 1 shows the results of students’ response to the learning based on STEM through the PjBL model. According to the result of the student responses towards student worksheets based on the STEM approach through the PjBL model, it showed that overall average percentages include in the good category. It indicated that the student worksheets based on STEM through the PjBL model obtained positive responses from the students. Learning using student worksheets based on the STEM approach through the PjBL model requires students to be able to learn.
for working together in a group so that the students can improve their problem-solving skills and they can be more active than learning without using student worksheets with PjBL model. The skill to collaborate and problem-solving are the skill expected to emerge in the 21st century so that because of these skills, the teacher can enhance the students’ interest and effectiveness gained from learning based on the STEM approach [17].

![Simple periscope of the student project.](image)

**Figure 1.** Simple periscope of the student project.

**Table 1.** Student response results toward student worksheets based on STEM through PjBL model.

| No | Evaluation Criteria | Score Average | Percentage Average |
|----|---------------------|---------------|--------------------|
| 1  | Working steps at the student worksheets facilitated me to understand the lesson | 3.3 | 84.2% |
| 2  | The guidance of working steps at student worksheets is clear | 3.2 | 82.4% |
| 3  | Writing and picture at student worksheets are clear | 3.4 | 85.1% |
| 4  | Project assignments given were relevant in daily life | 3.3 | 83.3% |
| 5  | Project assignments given were interesting and fun | 3.6 | 90.7% |
| 6  | Project assignments involved several lesson | 3.3 | 84.2% |
| 7  | Project assignments given facilitated me to get lots of new insights | 3.5 | 89.8% |
| 8  | I was given the freedom for completing the project with my wishes | 3.1 | 79.6% |
| 9  | The language used at student worksheets is clear and easy to be understood | 3.5 | 87.9% |
| 10 | The sentences used at student worksheets do not contain ambiguous meaning | 3.3 | 83.3% |

Project assignments contained in STEM-based learning by way of the PjBL model must be relevant to students’ daily life. STEM is an interdisciplinary approach to STEM learning in which students use science, technology, engineering, and mathematics in the real context balancing among school, the world of working and global so that the students can compete in facing a new economic era based on knowledge [7]. According to the result of students’ responses, it was determined that the project assignments and learning gave relevant in daily life had positive responses 83.3%. Giving assignments to accomplish the project in STEM-based learning through the PjBL model, the student can obtain a lot of new insights [18]. They can be acquired by the students when implementing the imagined stages in the Engineering Design Process (EDP) which is one of the characteristics from STEM and the second
step of the PjBL model is project planning design. Therefore, the students must know about finishing the project given [12] [19]. Conducting the learning by applying student worksheets based on STEM through the PjBL model, the students are also given the freedom to produce their best products appropriate with their creativity and knowledge.

Conclusion
Based on the results of the study, all statements on the students’ questionnaire to student worksheets that were used in STEM-based learning through the PjBL model showed a very good category. It indicated that after the students involved themselves in learning using student worksheets based on STEM through the PjBL model, they gave positive responses with a very good category. In general, STEM-based learning through the PjBL model has given a positive effect on the learning process so that it encourages the students to involve themselves in the learning because the process is really interesting and fun.

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