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Needs Analysis of The Development STEM-PjBL Based LKPD To Train Students' Critical Thinking Skills

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A B S T R A C T

Critical thinking skills is very important in the science learning process. Teaching materials are needed to encourage critical thinking skills. This research was conducted to analyze the needs of teachers and students for the development of STEM-PjBL based LKPD to train students' critical thinking skills. The research method used was descriptive to investigate the initial conditions. The research data was collected using an interview sheets and distributing needs analysis questionnaires through google form. The subjects of this study were physics teacher and 25 students of class XI IPA SMA in Tebing Tinggi. The datas were analysis using qualitative analysis techniques. The results showed that: (1) teachers had never used STEM-PjBL based LKPD before, (2) students were not familiar with learning activities that require critical thinking skills and they have difficulty in understanding the use of physics formulas, (3) students and teachers agree with the development of STEM-PjBL based LKPD to train critical thinking skills.

1. Introduction

Education has an important role because its main goal is improve the quality of human resources. In the era of industrial revolution 4.0, it is expected that students are able to face the demands of 21st Century learning. The purpose of 21st century learning is prepare human resources who have the ability to think critically, creative, collaborative, and communicative. Learning objectives can also polish and develop students' abilities through the 21st century learning (Putri et al., 2019). Learning in the 2013 curriculum implemented in Indonesia has used a student centered approach that provides opportunities to develop student skills and character building. Student centered learning is able to provide opportunities for students to develop their abilities because the learning system requires students to be more active and creative (Herwin et al., 2021; Rapanta, 2021).

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The competencies that must be possessed by students are attitude, skills, and knowledge competencies. One way to improve these competencies is by practicing critical thinking skills. Knowledge competencies is the ability of students to receive material, each student has different abilities and it is determined by the thinking ability of each student. Critical thinking skills are one of the things that are considered very important in the learning process (Huber & Kuncel, 2016). Nobody is born with the ability to think critically but it can be trained through learning activities. To solve mathematical and physical problems that students face requires critical thinking skills. Students can focus and think rationally in making decisions about what to believe to do through critical thinking. Therefore, critical thinking is very important to be trained to students. Critical thinking skills are also needed in real life, it needs to be developed so that students can use their thinking critically to solve the problems given and face the challenges of the 21st century (Fayakun & Joko, 2015; Mabruroh & Suhandi, 2017; Tiruneh et al., 2017).

Physics lessons require strong reasoning and its application is very important in everyday life to master science and technology. The scientific approach is closely related to physics lessons because this approach can broaden horizons and improve scientific skills. Students can improve their skills in solving the problems they face if they understood physics correctly. Concept mastery is very important to be improved in the teaching and learning process in order to achieve learning objectives. However, the learning process is still dominated by the teacher so that students were less able to apply critical thinking skills. Based on this, teaching materials are needed to encourage students' critical thinking skills and improve students' concept understanding.

Project-based learning (PjBL) is a student centered model that uses a project in the learning process. According to Bell (2010), the PjBL model has a positive effect on the 21st century skills, one of those skill is critical thinking ability. The PjBL model can be collaborated with the STEM approach. The industrial revolution 4.0 which prioritizes technology will certainly be strongly supported by the STEM approach. According to Corlu et al., (2014) that the main goal of STEM is to awaken innovative thinking patterns and foster interdisciplinary skills in the current generation to prepare students who excel in education. The stages of the PjBL model with the STEM approach are reflection, research, discovery, application, and communication (Stohlmann, 2019).

In applying the PjBL model with the STEM approach, teaching materials that support learning activities are certainly needed. The teaching materials in question are interesting and have a big influence on the success of the learning process and make students easly understood the subject matter. Based on the results of a questionnaire distributed to students, it was found that they were not accustomed to learning activities that related to science, technology, engineering and mathematics and students were not accustomed to practicing critical thinking. The results of interviews with physics teachers, researchers found that the LKPD used or developed by teachers have not been based on STEM-PjBL. Student worksheets (LKPD) are supporting learning activities to face the demands of the

21st century. However, the facts in the field show that LKPD is still in exercises form so this is very contrary to the true nature of LKPD which is a learning media for training 21st Century skills (Viyanti et al., 2020). In order to make LKPD more interesting, it is necessary to make innovations in preparing LKPD, namely by using approaches, methods, or learning models. Therefore, this research was conducted to analyze the needs of teachers and students for the development of STEM-PjBL based LKPD to train students' critical thinking skills.

2. Methodology

This research was conducted using a descriptive method to investigate the initial conditions whose results will be presented in the report form. The subjects of this study were physics teacher and 25 students of class XI IPA SMA in Tebing Tinggi. The research data was collected using interview sheets and distributing needs analysis questionnaires through *google form* to teachers and students of class XI IPA. This was done to obtain information about the needs of teachers and students for STEM-PjBL based LKPD teaching materials that can train students' critical thinking skills.

The data were analyzed using qualitative analysis techniques. According to Bogdan & Biklen in (Moloeng, 2014), qualitative analysis is an effort in organizing data to find and determine what is important to learn then decide what to tell with others. Table 1 shows the questions for teachers and students, which consists of 5 questions.

Table 1. Needs Analysis Questionnaire Questions

No.	Questions for Teachers	Questions for Students
1.	How is the learning strategy applied in learning Physics?	How is the learning strategy applied in learning Physics?
2.	What are the teaching materials used in physics learning?	What do you think is the most difficult Physics material to understand?
3.	Are the teaching materials you use appropriate for the project learning model with the STEM approach?	Are the teaching materials you use appropriate for the project learning model with the STEM approach?
4.	What do you think if STEM-PjBL based LKPD is developed?	What do you think if a STEM-PjBL based LKPD is developed?
5.	In your opinion, can the development of STEM-PjBL based LKPD on Dynamic Fluids improve students' critical thinking skills?	What kind of LKPD do you like?

3. Results and Discussion

Researchers in developing STEM-PjBL based LKPD that are adapted to the conditions of the learning environment and student needs to lead students to be able to relate learning concepts to the real world so it can improve critical

thinking skills. Needs analysis activities are carried out to obtain information about problems in physics learning. Researchers first conducted interviews with teachers to obtain information about student learning conditions. The results of the interview obtained are that during learning, students have less motivation to learn and critical thinking skills tend to be low when solving physics problems related to everyday life.

The results of the interviews conducted by researchers related to teaching materials owned by teachers indicate that the teaching materials or LKPD used are in the sufficient category. Teachers utilize LKPD as teaching materials. So far, teachers uses LKPD that is sourced from the publisher, downloads from the internet, and compiled by themselves. Based on questions from an interview sheet by teachers and students, the answers related to the needs of teaching materials are as follows. Table 2 shows the results of needs analysis of STEM-PjBL based LKPD by teachers.

Table 2. The Results of Needs Analysis of STEM-PjBL based LKPD by Teachers

No.	Question	Answer
1.	How is the learning strategy applied in physics learning?	Learning strategies used are inquiry, lectures, discussions, experiments and exercises
2.	What teaching materials do you use in physics learning?	Teaching materials used are: a. Textbook b. LKPD c. Module d. Teacher's book e. Student's book
3.	Are the teaching materials you use appropriate for the project learning model with the STEM approach?	Teachers had never used STEM-PjBL based LKPD.
4.	What do you think if we develop STEM-PjBL based LKPD on Diynamic Fluids?	Teachers agree and give a good response because it can support student involvement in learning activities and innovative in solving physics problems.
5.	In your opinion, can the development of STEM-PjBL based LKPD on Dynamic Fluids improve students' critical thinking skills?	Teachers agree and provide answers that can improve students' critical thinking skills.

Based on Table 2 on questions 1 and 2, the results show that the learning strategies used by teachers include inquiry, lectures, discussions, experiments, and exercises. The learning strategies and teaching materials used can encourage direct student involvement in learning activities. This is in line with previous study by Indriyana dan Susilowati (2020), students' critical and collaborative thinking skills in science learning can improve by using the PjBL model with the STEM approach. Students are actively involved in discussing with peers, analyzing projects, and working collaboratively in groups while working on projects. Teaching materials that are often used are textbooks, modules, LKPD, teacher books, student books. Based on research Islahiyah et al. (2021) that the

majority of teachers still use teaching materials in modules, package books, textbooks, and LKPD. The implementation of STEM-PjBL in learning activities can be applied in the form of Student Worksheets (LKPD). It is supported by Lestari et al. (2018), the results of their study showed that students' critical thinking skills increased after implementing LKS with the STEM approach.

In questions 3 and 4, obtained results about the teacher's opinion regarding the need for the development of STEM-PjBL based LKDP on dynamic fluids. Students have difficulty in understanding and applying formulas in terms of solving problems in dynamic fluids. This happens because students' mastery of concepts is still lacking. The teacher also stated that previously he had never used and developed STEM-PjBL based LKPD. Therefore, this LKPD must be designed in accordance with STEM-PjBL based components and emphasize understanding of student concepts through project activities undertaken by students so it can improve critical thinking ability.

The combination of STEM and PjBL can improve students' ability to explore, plan their learning activities, carry out projects collaboratively, and produce mini products in learning (Jauhariyyah et al., 2017). The STEM-PjBL can also increase student motivation and learning effectiveness (Afriana et al., 2016), as well as generate interest in understanding the material, able to generate students' creative attitudes (Tseng et al., 2013). In question 5, the teacher's agree that the development of STEM-PjBL based LKPD can improve students' critical thinking. This is in line with Dimmitt (2017) who recommends PjBL as the best method to increase independence and critical thinking skills which are very important for students to succeed in education.

Students can work together to create innovative solutions creatively and critically and communicate their solutions with others to solve real world problems through the incorporation of the 4C's and the STEM approach (Beers, 2011). In science learning, students must be able to construct their knowledge that makes them critical thinkers to answer problems. Based on the results of research conducted by Mutakinati et al. (2018), the implementation of STEM-PjBL was successfully fosters students' critical thinking, they are able to criticize their own plans to build realistic criticism of the strength of their thinking.
Table 3 shows the results of needs analysis of STEM-PjBL based LKPD by students.

Based on Table 3, students' responses were obtained regarding the need for STEM-PjBL based LKPD. The learning strategy applied by the teacher is discussion, lecturer, exercises, and experiments. Eight students answered that they had difficulty with dynamic fluids. Students also feel that there are many physics formulas and it is difficult to determine the formula used to solve problems. This is because their critical thinking skills are low so that it affects their conceptual understanding of physics material. Critical thinking ability is a thinking process that is one of the factors that can improve understanding of physics concepts so that learning methods and models that are adapted to the characteristics of subject matter are needed (Sari et al., 2016).

Table 3. The Results of Needs Analysis of STEM-PjBL Based LKPD by Students

No.	Question	Answer
1.	How is the learning strategy applied in physics learning?	The learning strategies used are discussions, exercises, and experiments.
2.	What do you think is the most difficult Physics material to understand?	8 students answered that the Dynamic Fluids was difficult.
3.	What makes it difficult for you to understand physics?	15 students answered that there were too many formulas and it was difficult to determine the formula used in solving the problem.
4.	What do you think if a STEM-PjBL based LKPD is developed?	All students answered agree with the development STEM-PjBL based LKPD.
5.	What kind of LKPD do you prefer?	20 students answered LKPD with illustrations of images accompanied by language that is easy to understand.

In questions 4 and 5, students' responses to the LKPD to be developed were obtained. All respondents answered that they agreed with the development STEM-PjBL based LKPD. A total of 20 respondents wanted LKPD accompanied by illustrative images and language that was easy to understand. Students tend to like LKPD that are easy to understand and not monotonous which only contains exercises. LKPD not only contains practice problems, but also contains simple practicum activities (Fahmidani et al., 2019) and contains instructions or work steps that students must do to answer the competencies that must be achieved by them (Prastowo, 2015).

LKPD that are easy to understand contain material that related to science, technology, engineering, and mathematics. The STEM-PjBL based LKPD is expected to help students improve their critical thinking skills which will have an impact on their concept understanding. The questionnaire has been distributed to 25 students of class XI IPA. Table 4 shows the results of student needs analysis questionnaire.

Table 4. The Results of Student Needs Analysis Questionnaire

No.	Questions	Percentages	
		Yes	No
1	Do you like physics lessons?	20,8%	79,2%
2	Do you use teaching materials such as LKPD in physics learning activities?	97,4%	2,6%
3	Is the LKPD used able to increase your learning motivation?	72,7%	27,3%
4	Are you familiar with learning activities that require critical thinking skills?	26%	74%
5	Does the teacher assign projects that link science, technology, engineering, and math in learning activities?	59,7%	40,3%

Physics is a difficult subject according to students, this is supported by Ady (2022) who stated that students have difficulty in understanding physics concepts because there are too many formulas and it is not interesting. This was also found by researchers through a questionnaire that distributed to students where many

students did not like physics lessons. The questionnaire results in Table 4 for question 1, it show that only 20.8% of students liked physics lessons. Based on open-ended questions given to students, 15 students answered that physics has too many formulas and students have difficulty in determining the formula that should be used to solve problems.

In line with prior finding by Samudra et al. (2014) that also showed (1) students consider physics is a difficult subject to understand because it contains mathematical elements, (2) students think physics needs to be learned but they do not know its usefulness. This is corroborated through research (Mbonyiryivuze et al., 2021) which revealed that many students with an average of 26% stated that learning physics was not fun, about 39% believed that physics had nothing to do with what they experienced and saw in the real world. Teachers has a rather important role in determining the right learning model to generate student interest in learning and interest in physics lessons.

Student interest in physics lessons can be fostered by leading students in learning activities that involve examples in the real world. This activity can be done by conducting experiments that produce a mini product. Based on responses obtained through questionnaires that have been distributed, physics lessons are not always project-based and have not linked to science, technology, engineering and mathematics. Learning activities that actively involve students in conducting scientific investigations to obtain better scientific concepts can be done by implementing STEM-based project learning.

Through the products which is produced in the project based learning, students can add learning experiences and increase scientific concepts (Capraro et al., 2013). In addition, activies in project based learning can increase students' critical thinking skills. To achieve this, students need to be familiarized with learning activities that require critical thinking skills. Based on Table 4 in question 4, it shows that 74% of students stated that they were not familiar with learning activities that require critical thinking skills. Therefore, researchers provide a solution to develop STEM-PjBL based LKPD so that students are accustomed to practicing critical thinking skills.

This solution is supported by previous research (Rosyidah et al., 2021; Sumardiana et al., 2019) that implementation of the PjBL model accompanied by STEM in learning activities, students' critical thinking skills increase and during the learning process students actively participate in finding solutions through project design. Afifah et al. (2019) in their research they found that the implementation of STEM-PjBL was able to increase students' concept understanding and critical thinking skills. Considering how importance critical thinking skills in the learning process, then a STEM-PjBL based LKPD is needed which is able to train students' critical thinking skills.

The STEM-PjBL based LKPD design based on the 2013 curriculum syllabus on dynamic fluid material in Class XI. Before compiling LKPD, the researchers first determines the learning objectives. LKPD based on STEM-PjBL contains cover,

preface, table of contents, instructions for use, subject matter, experiments and some questions that students must answer. Figure 1 shows part of the LKPD being developed, the cover page and instructions for using STEM-PjBL based LKPD.

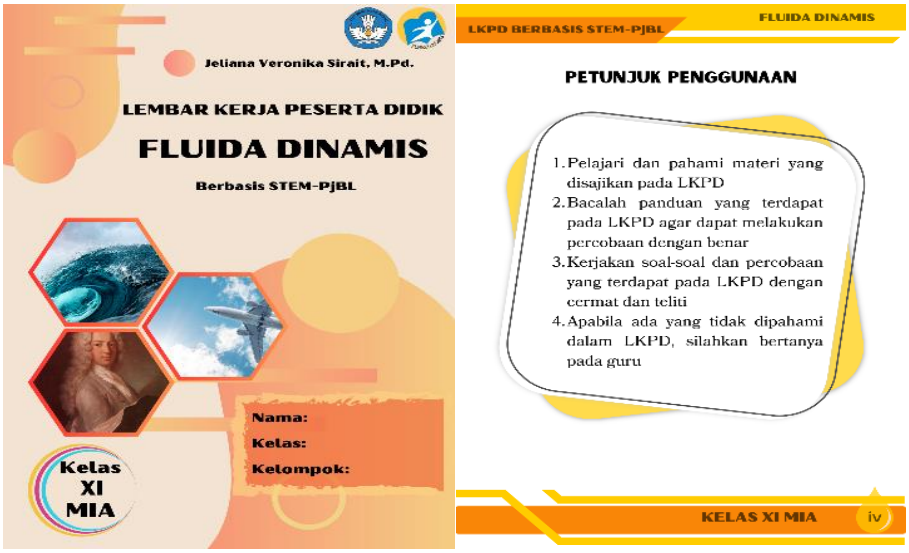

Figure 1. Cover and Instruction for using STEM-PjBL based LKPD

LKPD is adapted to the STEM-PjBL steps. The STEM-PjBL steps are reflection, research, discovery, application, and communication, (Stohlmann, 2019). The LKPD creation is processed with Microsoft Word 2016 and Canva applications. LKPD will be equipped with image illustrations and explanations to make an attractive appearance and as expected, which can train students' critical thinking skills.

4. Conclusion

Based on the results of the needs analysis through an interview sheet and questionnaires that have been distributed to teachers and students, researchers found that both teachers and students need STEM-PjBL based LKPD. The teacher's response shows that the teacher strongly agrees to develop STEM-PjBL based LKPD which can increase students' understanding of physics material and train students' critical thinking skills. Furthermore, student responses show that students agree with the development STEM-PjBL based LKPD and expect LKPD to be made as interesting as possible by loading illustrative images accompanied by language that is easy to understand.

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