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Design Thinking Strategy Integrated PjBL-STEM in Learning Program: Need Analysis to Stimulate Creative Problem-Solving Skills on Renewable Energy Topic

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Abstract: Currently, science education systems worldwide face global challenges, especially in anticipating the availability of renewable energy related to the Educational for Sustainable Development (ESD) theme. Problems related to reduce renewable energy reserves need special attention in education. This research is a descriptive survey that aims to determine the needs of teachers and students regarding learning programs on the topic of PjBL-STEM integrated renewable energy. Data collection used a questionnaire with 25 physics teacher and 57 high school students in Lampung Province. Based on survey results, only 40% of teachers have integrated learning programs with PjBL-STEM. In addition, it turns out that 52% of teachers and 77% of students do not know the objectives of the Sustainable Development Goals (SDG's). Then 85% of teachers and 59% of students experience problems in conducting learning on renewable energy topics, such as the lack of availability of media, tools, and teaching aids to carry out learning related to global issues, especially the case of renewable energy. In simpler terms, most teachers (82%) and students (86%) haven't used worksheets with activities to boost their Creative Problem Solving skills. Therefore, developing a learning program on PjBL-STEM integrated renewable energy is necessary.

Keywords: Creative problem-solving skills; Design thinking strategy; Learning program; PjBL–STEM; Renewable energy

Introduction

The development of knowledge, academic abilities, and thinking skills in students is a challenge in 21st-century learning. This challenge can be met by carrying out learning innovations that stimulate 21st-century skills. The 21st-century skills include 4C skills (Creativity, Communication, Critical Thinking, and Collaboration) recognized as a competency standard that students need to have to meet the demands of success in future work and life (Ağaoğlu & Demir, 2020; González & Ramírez, 2022; McGunagle & Zizka, 2020).

One important skill students need to learn in the 21st century is creative thinking (Hidayatullah et al., 2021; Iskandar et al., 2020). We need to teach students how to think creatively so that they can solve problems from different perspectives when they face difficult situations. Creative Problem Solving (CPS) is a way of thinking creatively to solve problems. It is an important skill that students need to learn in the 21st century (Singh, 2021). In physics-science learning right now, CPS is a difficult thing (Rokhmat et al., 2022; Sesriani, 2022). CPS skills are important for students to solve everyday problems. So, someone must have good problem-solving abilities (Lee et al., 2023; Rahma & Wicaksono, 2023).

Furthermore, science education systems around the world are faced with global challenges, especially in anticipating environmental changes related to sustainable development programs (Abdurrahman et

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al., 2023; Scott, 2021). In this regard, renewable energy is a global issue that needs to be addressed proceed to be wrong one concept in education (Febriansari et al., 2022; Rokhmat et al., 2022). However, as the need for energy increases, there is a massive exploitation of energy resources (Østergaard et al., 2020; Pacheco et al., 2019). Therefore, the education sector can help solve the energy crisis by teaching students about renewable energy and encouraging them to work on projects related to it (Podgórska & Zdonek, 2022; Pramesti et al., 2022).

The learning model that can be used for project-based learning is Project Based Learning (PjBL) (Fiteriani et al., 2021; Samsudin et al., 2020) The application of the PjBL model continues to experience development, one of which is the integration of PjBL with an approach. One approach that can be integrated with PjBL is the STEM approach (Science, Technology, Engineering, and Mathematics). STEM implementation can fulfill skills integration and content in the 21st century (Abdurrahman et al., 2019; Cheng & So, 2020). PjBL-STEM makes students actively involved and participates in the learning process (Purwaningsih et al., 2020; Rahmania, 2021).

PjBL-STEM, along with Design Thinking, which is often project-based learning, has brought significant changes to how we teach and learn (Chang & Yen, 2021; Chiu et al., 2020). However, PjBL-STEM integrated Design Thinking has not been widely used in learning, especially on renewable energy topics that are closely related to Education for Sustainable Development (ESD). PjBL-STEM integrated design thinking has been proven to make students more focused on utilizing knowledge from various scientific disciplines to synthesize and apply new knowledge (Henriksen et al., 2020). Additionally, using STEM integrated Design Thinking has been shown to help students come up with creative ideas to solve problems around them (Iskandar et al., 2020; Öztürk, 2021). This approach can also enhance skills that are important for the 21st century (Hasibuan et al., 2022) one of the things is called CPS, among others.

Thus, this research aims to determine the need to develop a Renewable Energy Learning Program with an integrated PjBL-STEM Design Thinking Strategy. We hope that the findings of this research will be used to create a program for learning about renewable energy. This program will combine project-based learning, STEM education, and design thinking to help improve our ability to solve problems creatively.

Method

This research is a descriptive survey conducted to determine the needs of teachers and students regarding learning programs on the topic of renewable energy with an integrated PjBL-STEM design thinking strategy to stimulate creative problem-solving skills. Descriptive research is not intended to test a particular hypothesis but to describe a variable or situation. One category of descriptive research is survey research (Purwaningsih et al., 2020). Then, for a preliminary study, a survey instrument is needed—a data collection technique using questionnaires. A questionnaire is an efficient data collection technique if the researcher knows for sure that the variables to be studied are measured and knows what is expected from the respondent. The questionnaire consists of the use and preparation of learning programs with PjBL-STEM integrated design thinking strategies to stimulate creative problem-solving skills and learning on topics that are in line with the objectives of the Sustainable Development Goals (SDG's). Each aspect contains open questions or statements that respondents need to answer and choose.

The type of data in this research is primary data, namely data taken directly from the results of student observation questionnaires. The data collection instrument is a questionnaire for teacher and student analysis. Data were collected using a questionnaire with 25 respondents who work as high school physics teachers and 57 respondents from high school students in the MIPA field in Lampung Province. Data collection was carried out using Google Forms to make it easier for researchers to distribute questionnaires. The data analysis technique used in this research was carried out by observing the percentages and graphs of the results of filling out the questionnaire by respondents.

Result and Discussion

This research is descriptive research conducted to determine the needs of teachers and students regarding learning programs on integrated renewable energy topics PjBL-SETM. The research was conducted by giving questionnaires to teachers and students. The respondents of this study were 25 respondents who work as high school physics teachers and 57 respondents from high school students in the MIPA field in Lampung Province Filling out the questionnaire is done online via Google form so that it is easy to disseminate.

The analysis we did looked at how many questionnaires were filled out by teachers and students to see what their needs were. The information we collected from the questionnaire about how project-based learning programs are used and prepared is shown in the diagrams in figures 1 and 2.

Figure 1 may be an instructor survey that describes the utilization of project-based learning programs within the learning preparation carried out by

instructors. It turns out that as it were 40% of instructors coordinated learning programs with PjBL-STEM. In the interim, in Figure 2, based on the survey filled out by students, it is outlined that the utilization of project-based learning programs within the learning preparation must be made strides assist. We are able to see within the diagram above that as it were 35% of their instructors utilize project-based learning programs in their lessons.

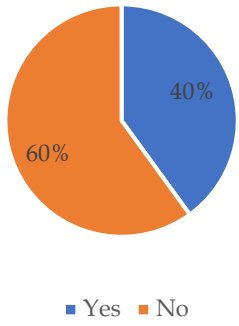

Figure 1. Diagram of using a project-based learning program based on a teacher's questionnaire

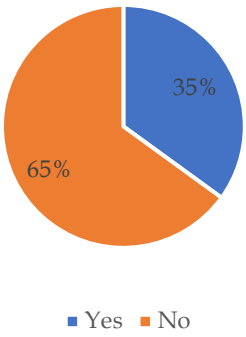

Figure 2. Diagram of using a project-based learning program based on a student questionnaire

Following, it contains questions to discover what impediments are experienced within the learning handle on the subject of renewable vitality. Based on the filling comes about, comes about are gotten as within the graph underneath:

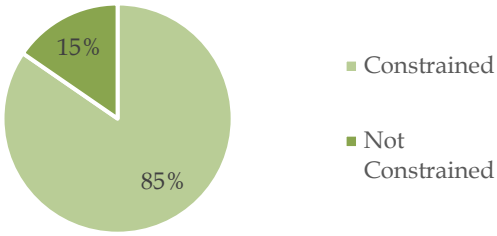

Figure 3. Diagram of learning constraints on the topic of renewable energy by the teacher

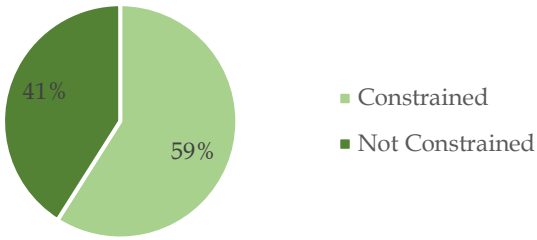

Figure 4. Diagram of learning constraints on the topic of renewable energy by students

Figure 3 illustrates that there are still many teachers who experience problems in conducting learning on the topic of renewable energy. It can be seen that 85 % experience problems in conducting learning on the topic of renewable energy. Then in Figure 4, as many as 5.9 % of students experience problems in carrying out learning on the topic of renewable energy.

The next aspect is asking about the extent of knowledge about the goals of the Sustainable Development Goals (SDG's) relating to the field of education. Based on the filling results, the results are obtained as shown in the diagram below:

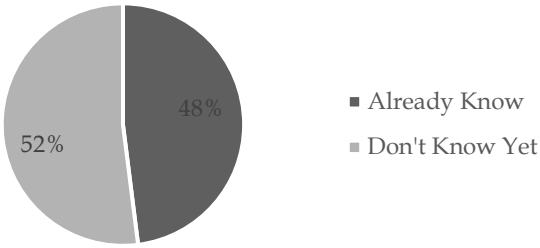

Figure 5. Diagram of knowledge of the SDG's objectives from the teacher's questionnaire

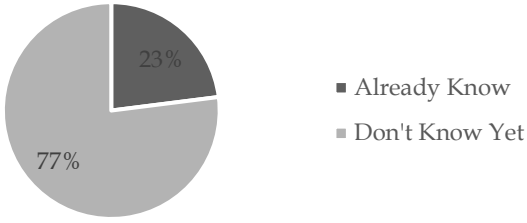

Figure 6. SDG's goal knowledge diagram from the student questionnaire

Figure 5 appears that 52% of instructors don't know the goals of the Maintainable Advancement Objectives (SDG's) related to the instruction segment and the same

thing additionally appeared in Figure 5, specifically that 77% of understudies don't know the goals of the Economical Development Goals (SDG's) related to the instruction division. So there's an association between information almost not knowing the goals of the Maintainable Development Goals (SDG's) and the deterrents experienced amid carrying out learning, particularly on the subject of renewable vitality which is closely related to the field of instruction.

The next aspect was inquiring to what degree worksheet was utilized amid learning on renewable vitality subjects. Worksheet is an additionally portion of the learning program. Based on the filling comes about, comes about are gotten as within the chart underneath:

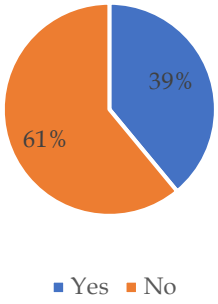

Figure 7. Diagram of using a worksheet from teacher response questionnaires

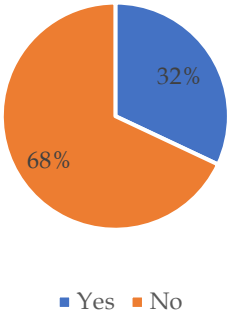

Figure 8. Diagram of using a worksheet from student response questionnaires

Figure 7 shows that 61% of teachers have not used worksheets when learning on renewable energy topics and the same thing is also shown by Figure 8, namely that 68% of students have not used worksheets when learning on renewable energy topics. So this is a special concern for researchers to be able to develop learning programs including worksheets. The next aspect was asked about the extent of student activity when using worksheets when learning on the topic of renewable energy. Based on the filling results, the results obtained are as shown in the diagrams in Figures 9 and 10.

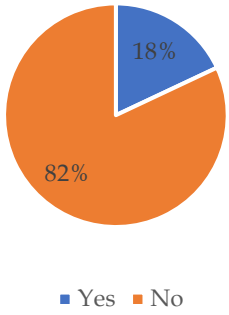

Figure 9. Diagram of using worksheet which allows students to find out for themselves based on the teacher's response questionnaire

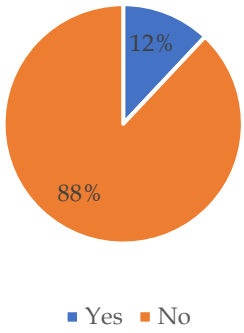

Figure 10. Diagram of using worksheet which allows students to find out for themselves based on a student response questionnaire

Figure 9 shows that 82% of the worksheet used did not have student activity to find out for themselves and the same thing is also shown in Figure 10, namely that 88% of students when using worksheets had not had the opportunity to find out for themselves regarding presenting a solution to a visible phenomenon.

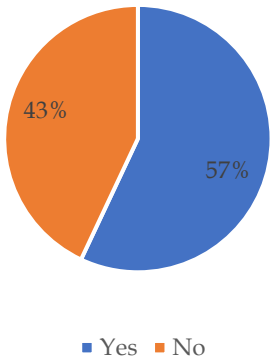

Figure 11. Activity diagram for students who want to use their thinking more creatively when learning renewable energy topics based on teacher response questionnaires

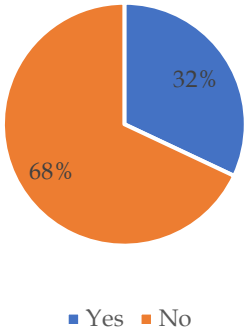

Figure 12. Response diagram for students who want to use their thinking more creatively when learning about renewable energy topics

Based on teacher responses, it can be seen in Figure 11 that 57% of students' activities have a desire to use their thinking power more creatively when learning on the topic of renewable energy. However, as shown in Figure 12, only 32% of students have the desire to use their thinking power more creatively when learning about renewable energy topics. This certainly shows that there are different points of view between teachers and students and there is a need for learning programs that can stimulate students to have the desire to use their thinking power more creatively when learning renewable energy topics.

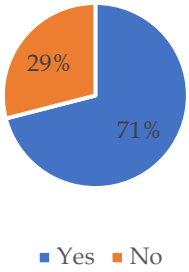

Figure 13. Activity diagram of students who wish to reflect while learning on the topic of renewable energy based on the teacher's response questionnaire

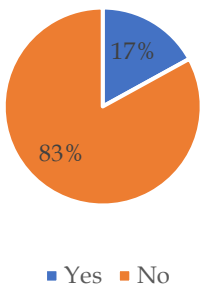

Figure 14. Diagram of student responses who wish to reflect while learning on the topic of renewable energy

Based on teacher responses, it can be seen in Figure 13 that 71% of students' activities reflect during learning on the topic of renewable energy. However, as shown in Figure 14, only 17% of students have the desire to reflect when learning on the topic of renewable energy. This certainly shows that there is a need for a learning program that can stimulate students to have the desire to reflect when learning on the topic of renewable energy. The next aspect was asked whether the worksheet used stimulated Creative Problem Solving skills. Based on the filling results, results are obtained as in the diagram below:

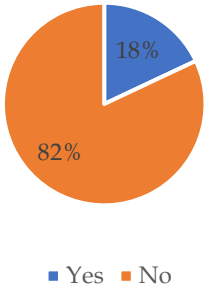

Figure 15. Diagram of using worksheet with activities to stimulate Creative problem-solving skills based on teacher response questionnaires

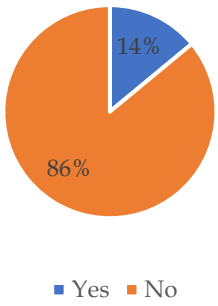

Figure 16. Diagram of using worksheet with activities to stimulate Creative problem-solving skills based on student response questionnaires

Figure 15 shows that 82% of teachers have not used worksheets with activities to stimulate Creative Problem Solving skills and the same thing is also shown in Figure 16, namely that 86% of students have not used worksheets with activities to stimulate Creative Problem Solving skills. So this is a special concern for researchers to be able to develop learning programs including worksheets with integrated PjBL-STEM to stimulate students' Creative Problem Solving skills.

The results of filling out the questionnaire regarding the use and preparation of learning programs revealed that only 40% of teachers integrated learning programs with PjBL-STEM. This certainly needs special attention, because integrating PjBL-STEM learning

programs it can stimulate 21st-century skills (Pramesti et al., 2022). Meanwhile, based on the questionnaire filled out by students, it was illustrated that the use of project-based learning programs was still lacking. The results are shown in the diagram that according to students only 3.5 % of students stated that their teachers used project-based learning programs in learning, especially on the topic of renewable energy. According to students, In the learning process about renewable energy heating, students are only asked to study independently, and students are rarely given practical learning. Students only understand material about renewable energy in theory, without knowing its application in real life, so students feel bored with the lecture learning model, causing a less enthusiastic attitude towards learning. After further digging, it was also found that students who did not participate actively in learning tended to pay less attention to the teaching materials provided, besides the teacher did not introduce and direct them at the beginning of learning.

Furthermore, it is known that 85 % of teachers and 59% of students experience obstacles in the learning process on the topic of renewable energy, such as the lack of availability of media, tools, and teaching aids to carry out learning related to global issues, especially the topic of renewable energy. Even the availability, use, and utilization of teaching materials are very important to support the optimization of learning outcomes (Rahmania, 2021). Therefore, teachers should be more proactive in preparing and using learning programs that can support optimal learning outcomes such as using PjBL-STEM-based learning programs (González-Pérez & Ramírez-Montoya, 2022).

The results of filling out the knowledge aspect questionnaire about the goals of the Sustainable Development Goals (SDGs) related to the education sector show that according to the results of filling out the teacher's questionnaire, 52 % of teachers and 77% of students do not know the goals of the Sustainable Development Goals (SDG's) and do not know the topics learning that falls within the scope of the SDG s. These two statements are in harmony which shows the lack of knowledge about the goals of the Sustainable Development Goals (SDG's) and learning topics that fall within the scope of the SDG's.

Based on the data that has been presented, several things need to be more consistent between teacher and student data. This is likely to occur because it is known that the respondents were teachers and students who randomly filled out the questionnaires distributed by the researcher. So there may be differences between schools and teachers causing the diversity of answers that arise. However, if it is focused on research objectives, it turns out that both teachers and students need project-based learning programs to support learning, especially on the topic of renewable energy. The use of PjBL-STEM-based learning programs can certainly have a good impact on the learning process such as teachers can maximize student work and creativity with coherent and organized teaching, o that students will be more focused on finding valid information for project learning and other things. In addition, a meaningful learning process is very much needed in renewable energy material and PjBL-STEM is a learning model that supports the creation of meaningful learning (Rahmania, 2021).

Conclusion

The research that has been conducted illustrates that based on survey results, based on the survey that has been conducted, only 40% of teachers have integrated learning programs with PjBL-STEM. In addition, it turns out that 52% of teachers and 77% of students do not know the objectives of the Sustainable Development Goals (SDG's) and do not know the learning topics that fall within the scope of SDG's. Then 85% of teachers and 59% of students experience problems in conducting learning on renewable energy topics such as the lack of availability of media, tools, and teaching aids to carry out learning related to global issues, especially the topic of renewable energy. In simpler terms, most teachers (82%) and students (86%) haven't used worksheets with activities to boost their Creative Problem Solving skills. Therefore, it is necessary to develop a learning program on the topic of PjBL-STEM integrated renewable energy.

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Author Contributions

The author's contribution to the field of education is to provide an overview of the application profile of PjBL-STEM along with the obstacles in learning physics, especially on the topic of renewable energy, as well as the lack of learning activities that can stimulate Creative problem-solving skills.

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Conflicts of Interest
No Conflicts of Interest.

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