Integrating STEM and PjBL Approaches for Character Development: Literature Review Retni S

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Abstract: This research has a general aim to foster the development of students' character through integrated STEM (Science, Technology, Engineering, and Mathematics) Project-based Learning (PjBL), and it has three specific objectives, namely to explain integrated STEM PjBL, integrated STEM PjBL teaching strategies, and the impact of integrated STEM PjBL on student character development. The research method used is literature review. This method involves the search and collection of information from various sources such as books, journals, articles, dissertations, theses, and other scholarly works related to the topic or issue under investigation. The results of this research indicate that integrated STEM PjBL can provide significant benefits to students in terms of motivation to learn, problem-solving skills, collaborative skills, and understanding of concepts. In the integrated STEM PjBL strategy, the teacher plays the role of a facilitator and mentor, providing guidance and constructive feedback to students at each stage of the project. Furthermore, integrated STEM Project-based Learning can have a positive impact on character development in students, especially in critical thinking skills, creativity, and collaboration.

Keywords: Integrated Science, Technology, Engineering, and Mathematics (STEM); Project-based Learning (PjBL) Approaches; Character Development.

1.Introduction

The development of human resources related to character is an effort to improve the quality of individuals and society by focusing on positive character development (Mardhiyah et al., 2021). Positive character is needed to face various challenges in life, both professionally and personally. Therefore, character development needs to be integrated into education and learning so that individuals can have the skills and positive values needed to be successful in life. Several things that need to be considered in developing human resources related to character include building social and emotional skills, cultivating a positive attitude, strengthening integrity, and forming a strong and independent personality (Sunarsi, 2018). In the educational context, character development can also help students to better understand moral and ethical values, so that they can become more responsible individuals and contribute positively to society (Putry, 2019).

A combination of the PjBL model (project-based learning) and STEM (science, technology, engineering, and mathematics) is a form of multidisciplinary learning (Sianturi, 2021). The PjBL model is a collaborative and constructivist learning model that focuses on students as the center of the learning process (Jalinus et al., 2017); (Han et al., 2016). This allows students to collaborate in solving problems and learn together to build understanding and knowledge. Through its implementation, the PjBL model utilizes student knowledge and skills so that learning can be more effective in improving learning outcomes, activities and student responses to learning (Almulla, 2020); (Jalinus et al., 2017).

According to Thomas and Michaelson, student participation in PjBL plays an important role in increasing new knowledge and skills (Noviyana, 2017). In the PjBL model, students are expected to be able to hold responsibility for the projects they are working on and collaborate in finding solutions to the problems they face (Pratama & Prastyaningrum, 2016). PjBL combines learning through real-world experiences with contextual learning methods (Rismawati et al., 2019). In the learning process, the teacher acts as a facilitator to facilitate students' active participation in learning activities (Siswono et al., 2018). Thus encouraging students to be independent and work together in determining goals, planning and organizing their learning activities (Kokotsaki et al., 2016).

Implementing the STEM integrated PjBL model on campus requires five supporting factors to achieve success, namely lecturers, students, learning management, learning facilities, and campus management, as stated by Solihin et al., (2021). Apart from these factors, the successful implementation of the STEM model also depends on the combination of various learning methods covering the four disciplines of STEM (Cheng, 2020). Apart from that, STEM integrated PjBL learning also has the potential to develop student character. Rangkuti (2019) stated that PjBL learning can improve and develop students' abilities in the field of soft skills.

2. Research Methods

In this study, the author chose to use library research methods. This method involves searching and collecting information from various sources such as books, journals, articles, dissertations, theses, and other scientific works related to the topic or problem being researched (Syafitri, E R, & Nuryono, 2020); (Christiana, 2020); (Syafitri, E R, & Nuryono, 2020). The aim of library research is to collect information that is relevant to the topic that will be discussed or is being researched. Literature research also aims to inform, analyze, combine and interpret concepts from previous research results that are closely related to the topic being discussed. According to (Anindayati & Wahyudi, 2020) library research can be interpreted as an effort to collect information that is relevant to the topic or problem that will be or is being researched by a researcher.

The literature research method was used in this research to develop a concept about the PjBL model which is integrated with the STEM approach to develop student character in science learning. According to (Sari & Asmendri, 2018), the stages in writing a literature review include selecting a topic, exploring information, determining the focus of the study, collecting data sources, preparing data presentation, and preparing a report. In this research, the data analysis technique used is the content analysis method. This method is used to obtain valid inferences and can be checked again based on the context.

3. Results and Discussion STEM Integrated PjBL Model

According to Wilson (2020), PjBL is a learning approach that involves students in authentic project activities, which reflect real world challenges and require the application of knowledge and skills in relevant and meaningful contexts. According to Essien (2018) said that PjBL encourages students to develop skills needed in the real world, such as critical thinking, collaborating, communicating, and solving problems, while deepening their understanding of the topics studied. Cifrian et al., (2020) explained that PJBL places students at the center of learning and gives them control over their own learning process. Through relevant and challenging projects, students learn how to think, work together, and take responsibility for their own learning (Shin, 2018). It can be seen that PJBL is a learning model that involves students in project activities that are authentic and relevant to the real world, so that it can help students develop the skills needed in real life. In PJBL, students are given the opportunity to take control of their own learning process and learn how to think, work together, and take responsibility for learning.

According to (Uziak, 2016) there are several characteristics in learning Project-based learning (PjBL), including:

1. Have clear learning objectives: Project-based learning is focused on learning goals, not the project itself. This means that PjBL learning must have clear objectives and be related to the competencies that students want to achieve.
2. Involving students in decision making: "Students have voice and choice in their learning. In PjBL learning, students must be involved in decision making regarding the topic or problem to be explored, as well as how they want to solve the problem.
3. Problem based: "Projects are focused on solving real-world problems or answering complex questions". PjBL learning should focus on solving real-world problems or answering complex questions.
4. Collaborative: "Students work collaboratively to accomplish project goals." In PJBL learning, students work together in groups to achieve learning goals.
5. Integrative: "Projects integrate multiple subjects and 21st century skills." PjBL learning must integrate several 21st century subjects and skills to achieve learning goals.
6. Using real-world resources: "Students use real-world resources in the classroom to explore and understand the project's content." PjBL learning should incorporate real-world resources in the classroom to broaden students' understanding of the topic being explored.

With these characteristics, PjBL learning can help students develop critical, collaborative and integrative skills that are important for success in the real world.

Learning model Project-based learning (PjBL) integrated STEM is a learning approach that integrates the concepts of science, technology, engineering and mathematics (STEM) in a learning project. In the STEM integrated PjBL model, students work collaboratively in a team with the aim of creating innovative and creative solutions to the problems they face. This student-centered learning process is designed to promote critical, creative, and innovative thinking, as well as problem-solving abilities. Apart from that, this approach also helps students to develop social skills such as teamwork, communication and leadership.

STEM Integrated PjBL Model

The Project Based Learning (PjBL) STEM model is a learning model that integrates science, technology, engineering and mathematics (STEM) concepts into project-based learning. In this model, students are given challenging and interesting project assignments, which involve using STEM concepts to solve complex problems. Learning is carried out by means of exploration, collaboration and reflection. The PjBL STEM model draws on traditional project-based learning (PjBL), which emphasizes active and collaborative learning. However, this model adds a STEM dimension, allowing students to not only learn science concepts, but also technology, engineering, and mathematics. This model aims to help students develop critical, creative and logical thinking skills in dealing with real world problems.

The PjBL STEM model has several distinctive characteristics, including:

1. Apply project-based learning to solve real-world problems.
2. Integrates science, technology, engineering, and mathematics concepts.
3. Encourage students to think critically and creatively in solving problems.
4. Develop social skills such as collaboration, communication, and leadership.
5. Provide opportunities for students to reflect and evaluate their learning outcomes.

In the PjBL STEM model, teachers act as facilitators and companions, not as task givers. Teachers guide students to conduct exploration and research, as well as provide feedback and evaluation of student work results. The PjBL STEM model provides a different and interesting learning experience for students, so that it can increase students' learning motivation and interest in STEM.

The STEM integrated Project Based Learning (PjBL) strategy involves several stages in its implementation, including:

1. Identify challenging project problems or topics.
2. Planning a project.
3. Conduct exploration and research.
4. Design and develop solutions.
5. Implementing projects.
6. Analyze the results and reflect.
7. Presentation of project results.

A learning scenario is a learning plan that describes the steps and activities that must be carried out in a learning session. This scenario is prepared by the lecturer as a framework or learning design which will later be used in teaching and learning activities in class. Learning scenarios must contain several important information such as learning objectives, learning materials, learning methods or strategies that will be used, as well as assessment or evaluation of learning that will be carried out. In preparing learning scenarios, lecturers must pay attention to the learning context, student abilities, and available technology.

Learning scenarios on strategy Project-based learning STEM can be used by lecturers in preparing learning frameworks or designs by paying attention to the following things:

1. Determine the topic or theme that will be addressed inproject-based learning.
2. Form a team or group to carry it outproject-based learning.

3. Make a plan or work plan which includes objectives, scope, resources, schedule and evaluation.
4. Carrying out research or exploration activities on predetermined topics.
5. Designing solutions or product designs or results that will result fromproject-based learning.
6. Carrying out projects or creating products or results.
7. Analyze and evaluate resultsproject-based learning.
8. Present results and obtain feedback.

In preparing a learning framework or design with strategyProject-based learning STEM, lecturers need to pay attention to the stages above and ensure that all stages have been implemented properly and in accordance with the goals to be achieved.

The impact of STEM in developing student character growth

The implementation of STEM integrated project based learning has a positive impact in developing student character growth. Some of the characters that can be developed through this learning include creativity, collaboration, innovation, problem solving, critical thinking skills, and communication skills.

A research conducted by Cifrian et al., (2020) shows that STEM integrated project based learning can improve students' critical thinking skills and creativity. Apart from that, this learning also helps students expand their knowledge and develop the ability to collaborate with classmates. The results of this research show that STEM integrated project based learning can improve student character through developing skills and social skills. Another study conducted by Han et al. (2016) shows that STEM integrated project based learning can also help students develop leadership characteristics. Students who take part in this learning become more skilled at leading teams and making the right decisions in complex situations. Overall, STEM integrated project based learning can help develop students' character growth by strengthening their skills and social skills through interactive and collaborative learning.

4. Conclusion

STEM-integrated PjBL learning can provide significant benefits for students in terms of learning motivation, problem-solving abilities, collaboration skills, and concept understanding. However, further research is needed to strengthen these findings and explore other aspects of STEM-integrated PjBL learning. In the STEM integrated PjBL strategy, lecturers act as facilitators and companions, and provide guidance and constructive feedback to students at each stage of the project. This strategy emphasizes active and collaborative learning, and integrates science, technology, engineering and mathematics concepts, allowing students to develop skills that are relevant to STEM and can be applied in real life. Project-based learning Integrated STEM can have a positive impact in developing students' character growth, especially in the aspects of critical thinking skills, creativity and collaboration.

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