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IMPLEMENTATION OF PROJECT-BASED LEARNING THROUGH THE STEM (SCIENCE, TECHNOLOGY, ENGINEERING AND MATH)

Agus Lestari[1], Friscilla Wulan Tersta[2], Firman[3], Sofyan[4]
Universitas Jambi, Indonesia
aguslestari@unja.ac.id; friscillawulant@unja.ac.id

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Abstract

The background of this research is the lack of student motivation in learning. This can be seen from students' inactive involvement, lack of enthusiasm in lessons, and low critical thinking skills. This research aims to implement project based learning using a STEM (Science, Technology, Engineering, and Mathematics) approach in training students' critical thinking skills. The research informants are Jambi University FKIP Education administration students who contract teaching and learning courses. A qualitative approach with case study design is used in this research to explore real world problems, and Focus Group Discussions (FGD) and several literature studies are used as collection techniques. data. The research results show STEM as a growing trend in the world of education, used to overcome real-world situations through a design-based problem solving process. Project-based learning allows students to apply what they learn to real-world problems and challenges, which helps them develop critical thinking and problem-solving skills. With the STEM approach in project-based learning, students can learn scientific methods, engineering design, and computational thinking while working on

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projects that require them to apply concepts to gain a deeper understanding. It can be concluded that project-based learning can increase student involvement and motivation by making learning more relevant and meaningful.

Keywords: Project-Based Learning, STEM Approaches

INTRODUCTION

One of the essential skills that a teacher must possess in their professional duties is understanding how students learn and how to conduct a learning process that develops skills and builds student character (Zakiah et al., 2019). To comprehend the learning process of students, teachers must master the essence and basic concepts of learning. With an understanding of the essence and basic concepts of learning, it is expected that teachers will be able to apply them in learning activities, as the main task of teaching is to encourage the growth and development of student learning (Winataputra et al., 2014). The term "learning" is frequently used in the field of education, as regulated by the Republic of Indonesia's Law Number 20 of 2003 on the National Education System, which legally defines the concept of learning. In Article 1, Clause 20, learning is defined as "... the process of interaction between students, educators, and learning resources in a learning environment." Learning, as a pedagogical concept, can be technically defined as a systematic and organized effort to create a learning environment that has the potential to produce a learning process directed towards the development of students' individual potential.

Based on this understanding, the teaching and learning process seems to have a material and functional relationship with each other. The material relationship between learning and teaching is the core of human behavior change. The functional relationship between learning and teaching is that teaching occurs consciously to produce learning; in other words, learning is the parameter of teaching. In the context of the Educational Administration Study Program, the course "Learning and Teaching" is a mandatory course for students in educational programs, carrying a weight of 3 credits. This course examines and analyzes various theories of learning and teaching from the perspectives of educational experts, covering concepts of learning, types of learning, principles of learning, and learning resources, which can serve as references for conducting teaching. It develops an understanding of the application of approaches, strategies, models, and teaching methods,

as well as teaching skills, to be used in analyzing real-world teaching cases. The presence of the "Learning and Teaching" course in the Educational Administration Study Program has sparked debate among students, as not all Educational Administration students intend to become future teachers. Additionally, there are several issues arising in the classroom.

Therefore, the solution offered by the Faculty Team is to use the STEM approach. There are many pros and cons regarding the application of STEM in the humanities. This is because previous research indicates that the STEM approach tends to be used in exact sciences study programs. However, in line with the development of science, the STEM learning approach is a logical choice that can be applied across various fields of study. As a growing trend in the world of education, STEM is used to address real-world situations through a design-based problem-solving process (Williams, 2011). Besides problem-based learning, the STEM approach (Science, Technology, Engineering, and Mathematics) has become an important part of modern education, and project-based learning is an effective way to teach these subjects. Project-based learning allows students to apply what they have learned to real-world problems and challenges, helping them develop critical thinking and problem-solving skills.

In addition, project-based learning can enhance student engagement and motivation by making learning more relevant and meaningful (Hartono & Asiyah, 2019). When STEM is integrated with project-based learning, students can learn about the scientific method, engineering design, as well as computational and critical thinking while working on projects that require the application of these concepts (Dywan & Airlanda, 2020). This approach can help students develop a deeper understanding of the course material and learning process, as well as prepare them for future careers.

Therefore, this study will explore various aspects formulated in the question: How is the implementation of Project-Based Learning through the STEM (Science, Technology, Engineering, and Math) approach in training Critical Thinking Skills for Educational Administration students in the Learning and Teaching course. The aspects considered in this research focus on learning and teaching. This course examines various theories of learning and teaching based on different perspectives of educational experts, covering concepts of learning, learning methods, learning principles, and learning resources that can be used in teaching. It aims to develop an understanding of the application of teaching

methods, strategies, models, and techniques, as well as teaching skills, for use in analyzing real-world teaching cases.

METHODS

This research employs Action Research (Barcelona, 2020). A qualitative approach with a case study design is used in this study to explore real-world issues (Assyakurrohim et al., 2023), and Focus Group Discussion (FGD) is utilized as the data collection technique (Afiyanti, 2008). The research is conducted in the Learning and Teaching course class of the Educational Administration study program at FKIP Universitas Jambi, during the odd semester of the 2023/2024 academic year. The study aims to implement Project-Based Learning through the STEM (Science, Technology, Engineering, and Math) approach in training the Critical Thinking Skills of Educational Administration students in the Learning and Teaching course. This section discusses the research methods, design or type of research, participants/subjects (population & sample), data collection techniques, and data analysis techniques. It also includes the time and place of the research, subjects/participants/respondents, procedures, research instruments, and other related aspects of conducting research. For both qualitative and quantitative research, the time and place of the research need to be clearly stated. The subjects/participants/respondents (for qualitative research) or the population and sample (for quantitative research) must be clearly described in this section. The technique for obtaining subjects (in qualitative research) or the sampling technique (in quantitative research) should also be mentioned. The procedure should be detailed according to the type of research. How the research is conducted and how data will be obtained should also be explained in this section.

RESULTS

1. Project-Based Learning

The recommended learning model for use in the 2013 curriculum is a student-oriented learning model, one of which is project-based learning (Fajarini, 2022). The curriculum implementation module (2013) explains that Project-Based Learning is a learning model that uses projects/activities as the core of the learning process. Students

engage in research, evaluation, interpretation, synthesis, and knowledge application to create various forms of learning.

The project-based learning model has significant benefits for students. However, it is seldom used by teachers because its implementation requires considerable preparation and is time-consuming. Mulyasa states that project-based learning, or PjBL, is a learning model aimed at focusing students on complex problems that require research and understanding through investigation (Mulyasa, 2014).

The goal of this model is also to guide students in collaborative projects that integrate various curriculum subjects (content), offering students the opportunity to learn content in different ways that suit them, and to conduct collaborative experiments. According to Daryanto, Project-Based Learning (PjBL) is a learning model that uses problems as a starting point to gather new information and integrate it into real-world experiences and activities (Daryanto, 2012).

PjBL is designed to be used on complex problems that require students to conduct investigations and understand them (Patton, 2012). Sugihartono further states that the project method is a teaching method where students are presented with learning material derived from a problem source, which is then discussed from various perspectives to arrive at a comprehensive and meaningful solution. Students address the problem from their own perspectives according to their interests and abilities (Sugihartono, 2015).

Fathurrohman also states that project-based learning is a learning model that uses projects/activities as a means of achieving mastery in attitudes, knowledge, and skills. This type of learning is gradually replacing teacher-centered learning. The focus of this learning approach is on student activities that can produce meaningful and beneficial products at the end of the learning process (Fathurrohman, 2015). According to Saefudin & Berdiati (2014), project-based learning is a learning method that uses problems as a starting point to gather and integrate new information based on real-world activity experiences.

Project-based learning emphasizes contextual problems that can be directly experienced by students, encouraging them to think critically and develop their creativity by creating tangible products, whether goods or services (Tekisendi, 2020). Meanwhile, according to Isriani, project-based learning is a model that provides teachers with the opportunity to control classroom learning through project work (Isriani & Puspitasari, 2015).

Based on the various definitions provided by experts, it can be concluded that the Project-Based Learning (PjBL) model is a student-centered learning approach that begins with a problem background, followed by investigation so that students gain new experiences through real activities in the learning process and can produce a project to achieve affective, cognitive, and psychomotor competencies. The final outcome of the project work includes a product such as a written or oral report, presentation, or recommendation.

2. STEM

In the STEM method (Fathoni et al., 2020), it is essential to emphasize several aspects of the learning process, including: 1. Asking questions (science) and defining problems (engineering), 2. Developing and using models, 3. Designing and conducting investigations, 4. Analyzing and interpreting data (mathematics), 5. Utilizing mathematics; information technology, data, and computational thinking, 6. Conducting structured research (science) and planning solutions (technology), 7. Engaging in evidence-based arguments, 8. Acquiring, evaluating, and communicating information.

Here are the effective steps for STEM-based PjBL:

a. Reflection: The goal of this first step is to bring students into the context of the problem and stimulate them to start their research. This stage also aims to integrate what is known with what needs to be learned.

b. Research: This activity involves student research. The instructor organizes the lessons systematically, selecting materials or methods to gather relevant information. At this stage, more learning processes occur, with student progress turning abstract understanding of the problem into concrete outcomes. During the inquiry phase, the instructor often leads discussions to determine whether students have developed a conceptual and meaningful understanding based on the project.

c. Discovery: The discovery phase typically involves combining research and known knowledge in preparation for the project. As students begin to learn independently and identify what they do not yet know, some STEM-based PjBL models divide students into small groups to present solutions to a problem, collaborate, and build teamwork within their groups.

d. Application: The goal of the application stage is to test the product/solution in solving a problem. In some cases, students test the products they create under predetermined conditions. In other models, students at this stage learn about the broader context beyond STEM or make connections between different STEM disciplines.

e. Communication: The final task of each project is to create a product/solution and communicate it to peers and the class. Presentation is a crucial step in the learning process where communication and collaboration skills are developed, as well as the ability to receive and apply constructive feedback. Evaluation is often based on the successful completion of the project.

DISCUSSION

Activity Design

The design of the learning activity for implementing Project-Based Learning through the STEM (Science, Technology, Engineering, and Math) approach to develop the Critical Thinking Skills of Educational Administration students in the Learning and Teaching course is illustrated as follows:

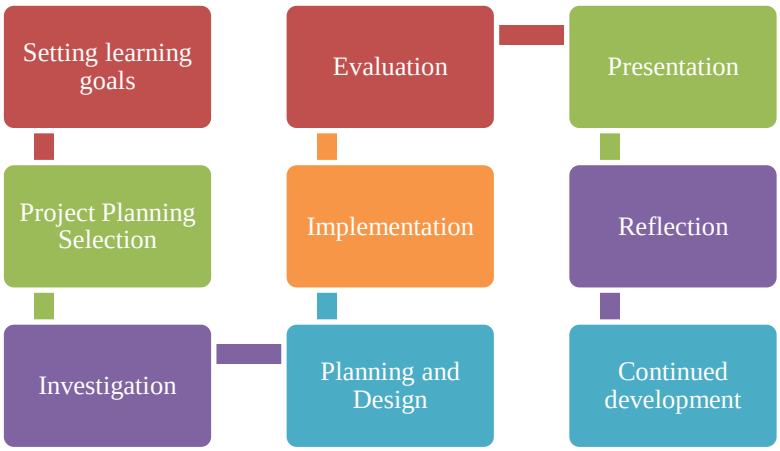


Figure 1. Project Based Learning Activity Design through a STEM approach

1. Learning Objectives:
   a. Understand the basic concepts of learning and learning in educational administration.
   b. Develop analytical, problem solving and creativity skills.

c. Improve teamwork, communication, and leadership.

d. Integrating science, technology, engineering and mathematics in the context of Teaching and Learning in Educational Administration.

2. Project Planning Selection

a. Select a relevant project topic related to Learning and Teaching in Educational Administration, such as the development of learning and teaching methods, learning models and methods, learning management, or program evaluation.

b. Organize students into small groups to work collaboratively on the project.

c. Establish a realistic project schedule, assign tasks, and set deadlines.

3. Investigation

a. Students conduct investigations on their project topic.

b. Collect data, analyze literature, or conduct interviews with education practitioners.

4. Planning and Design

a. Students plan the steps they will take in the project.

b. Determine the methods and tools required to complete the project.

c. Create designs or models that illustrate the proposed solution.

d. They also determine how STEM can be applied in the planning and execution of the project.

5. Implementation

a. Students implement their plans and engage in activities related to Learning and Teaching in Educational Administration.

b. They may arrange meetings with field practitioners or organize role simulations.

6. Evaluation

a. Students evaluate the results of their project based on previously established criteria.

b. They may also receive feedback from group members and the instructor.

7. Presentation

a. Students present the results of their project to the group and the instructor.

b. They explain the process, findings, and solutions they have developed.

c. Discussions and Q&A sessions are held to further develop understanding.

8. Reflection

a. Students reflect on their experiences in carrying out the project.

b. They identify strengths, weaknesses, and lessons learned from the experience.

c. Reflection can be done either in writing or through group discussions.

9. Assessment

a. Students are assessed based on the quality of their project, presentation, and reflection.

b. Assessment criteria include conceptual understanding, analytical ability, teamwork, and creativity.

10. Further Development

a. The results of the project can serve as a foundation for further development in educational administration.

b. Students are encouraged to continue developing their solutions on a larger scale, such as through publication, conferences, or submitting proposals for improvements to relevant educational institutions.

11. Storage and Information Sharing

a. Students are required to store their project documentation, including reports, presentations, and other relevant materials.

b. This information may be shared with fellow students or used for further reference and understanding.

By following this Project-Based Learning design, students in the Educational Administration program can develop a deeper and more contextual understanding of Learning and Teaching in educational administration through real-world projects, as well as integrate STEM elements in problem-solving and decision-making. Additionally, they will also hone collaboration, communication, and critical thinking skills that are essential in the professional context of educational administration (Ritonga & Zulkarnaini, 2021).

Contribution

This research provides theoretical, practical and professional contributions in implementing the Project-Based Learning approach with a STEM approach in Learning and Teaching courses in the Educational Administration study program. as follows:

Theoretically, this research contributes to the application of the Project-Based Learning approach combined with STEM in the context of the Learning and Teaching course within the Educational Administration program. The concepts and principles of both Project-Based Learning and STEM approaches are theoretically examined and integrated into the learning design, providing a deeper understanding of how these approaches can be effectively applied in educational administration.

Practically, this research offers practical guidance on implementing Project-Based Learning with a STEM approach in the Learning and Teaching course of the Educational Administration program. The proposed learning design provides a clear framework for the steps, methods, and strategies that instructors can use to develop and teach the course. Students will benefit from a more active learning experience, engaging in real-world projects, and developing practical skills relevant to educational administration.

CONCLUSION

Based on various literature reviews and previous research, STEM (Science, Technology, Engineering, and Mathematics) has emerged as a growing trend in education, used to address real-world situations through design-based problem-solving processes. Additionally, the STEM approach has become an important component of modern education, and Project-Based Learning (PjBL) is an effective method for teaching this subject. Project-Based Learning allows students to apply what they have learned to real-world problems and challenges, helping them develop critical thinking and problem-solving skills. When STEM is integrated with Project-Based Learning, students can explore scientific methods, engineering design, and computational thinking while working on projects that require the application of concepts for deeper understanding. It can be concluded that Project-Based Learning can enhance student participation and motivation, making learning more relevant and meaningful. Recommendations for future research include evaluating the effectiveness of PJBL with a STEM approach and measuring user

satisfaction, specifically from students, as well as assessing the extent to which these methods and approaches impact their understanding of specific content.

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