Building a Future Generation of Entrepreneurs: An Experimental Study of the Integration of PBL and AI in Entrepreneurial Education

Hariyono
STKIP PGRI NGANJUK, Indonesia
hariyono@stkipnganjuk.ac.id

Corresponding Author: hariyono@stkipnganjuk.ac.id

Abstract
This study investigates the effectiveness of integrating Project-Based Learning (PBL) with Artificial Intelligence (AI) in teaching entrepreneurship. Using a quasi-experimental design, the research involved two experimental groups: AI-assisted PBL and a control group (traditional PBL and lecture-based learning). The results indicate that, compared to the control group, the entrepreneurial skills of students were significantly enhanced through the integration of PBL and AI. The findings suggest that PBL and AI can be effective methods for teaching entrepreneurship. This study demonstrates that PBL combined with AI can help students develop the necessary skills and knowledge to become successful entrepreneurs.

Keywords: Project-Based Learning, Artificial Intelligence, Entrepreneurship Education, Entrepreneurial Skills.

INTRODUCTION
Recent research across various regions and sectors has shown that entrepreneurs significantly contribute to economic and social growth through multiple mechanisms (Aynaddis, 2023). Talent management and entrepreneurship are closely correlated in driving sustainable economic growth (Liu et al., 2023). Entrepreneurs directly contribute to economic growth by creating new jobs. They are affirmed as a vital force in business growth and community development; entrepreneurial initiatives, education, and culture significantly influence business innovation and economic development through innovation (Zemlyak et al., 2023). The personal economic impact and risk management involved in entrepreneurship are evidenced by the economic well-being of entrepreneurial households, demonstrating their ability to maintain a reasonable standard of living and invest in new businesses (Reddy, 2023). Entrepreneurs develop new products and services, create new jobs, and contribute to innovation and technological advancement. They
have become increasingly important in the current era of digitalization and globalization for enhancing a country’s competitiveness and addressing various global challenges.

As highlighted by Ferdiansyah & Permana (2022), the number of young entrepreneurs and startups is rising worldwide. Entrepreneurs also drive innovation and technological advancement and contribute to the creation of new products and services (Indarto & Prawihatmi, 2021). National entrepreneurial systems are significantly impacted by these innovations, which are crucial for driving economic growth. These systems can also boost total factor productivity (TFP) by enhancing the effects of creative entrepreneurship (Svetek & Drnovsek, 2021). This trend reflects the youth’s enthusiasm for entrepreneurship and its substantial potential to aid in economic and social development. However, young people need adequate education and training to become successful entrepreneurs.

Entrepreneurship education is crucial for fostering future generations of entrepreneurs as it instills innovation and entrepreneurial intentions among students, ensuring a sustainable supply of entrepreneurial talent that can sustain economic growth and innovation (Georgescu & Herman, 2020). The aim of entrepreneurship education is to equip young people with the knowledge, skills, and attitudes necessary to become successful entrepreneurs. Schools, colleges, and other educational institutions typically offer entrepreneurship education.

Traditional entrepreneurship education methods often focus on theory and case studies. These methods have several limitations, including a lack of practical experience and the inability to depict real-world business situations effectively. Entrepreneurship has the potential to reduce poverty, drive economic growth, enhance innovation, and promote social and environmental sustainability (Supriandi & Priyana, 2023). However, the effectiveness of entrepreneurship education and training (EET) in achieving sustainable development goals (SDGs) faces challenges, particularly in vulnerable environments. Therefore, creative approaches are needed to address these issues.

New, more efficient methods for entrepreneurship education are needed. Project-Based Learning (PBL) and Artificial Intelligence (AI) are considered beneficial methods. Project-Based Learning (PBL) is a student-centered learning method where students learn by engaging in real-world projects. Effective PBL helps learners develop scientific process skills and become accustomed to the learning process (Ali, 2019). AI is a field of computer science focused on creating intelligent agents that can learn, reason, and act autonomously (Manning, 2020).

The focus of this research is the problems faced by traditional entrepreneurship education, which is often ineffective in producing successful entrepreneurs. Traditional approaches centered on theory and case studies frequently fail to provide practical experience and real-world simulation. This leads to a gap between what is taught in entrepreneurship education and what
entrepreneurs need to succeed in the field. These limitations hinder the younger generation from becoming successful entrepreneurs.

The objective of this research is to fill the gap in existing studies regarding the effectiveness of integrating Project-Based Learning (PBL) and Artificial Intelligence (AI) in teaching entrepreneurship to students. This study is among the first to investigate the use of PBL and AI in entrepreneurship education at the college level, differing from previous research that focused on the use of PBL and AI in primary and secondary education. This study aims to enhance our understanding of how PBL and AI can be used to improve entrepreneurship education and help the younger generation become successful entrepreneurs.

Several elements make this research significant: (a) the integration of PBL and AI in entrepreneurship education, (b) opportunities to improve the quality of entrepreneurship education, (c) significant impact on educational policy and teaching practices, and (d) alignment with global trends in entrepreneurship education. Consequently, this research can significantly contribute to the knowledge and practice in the field of entrepreneurship education.

Therefore, the aim of this research is to find creative solutions for integrating Project-Based Learning (PBL) and Artificial Intelligence (AI) in entrepreneurship education. It is hoped that this integration can address the limitations of traditional approaches and improve the quality of entrepreneurship education by producing successful entrepreneurs.

METHOD

In this study, a quasi-experimental design was employed with two groups: an experimental group and a control group (Moradi et al., 2022). This method has been widely used in health and behavioral research, as evidenced by various studies (Moradi et al., 2022). The experimental group received Project-Based Learning (PBL) integrated with Artificial Intelligence (AI) in entrepreneurship education, while the control group received conventional entrepreneurship education. This design was chosen to test how well PBL and AI interventions enhance students’ entrepreneurial skills. PBL requires students to solve problems, seek information, and create their own solutions.

All students enrolled in the entrepreneurship course at STKIP PGRI Nganjuk during the third semester were the subjects of this study. Four programs (English Education, Mathematics Education, Primary School Teacher Education, and Physical Education, Health, and Recreation) included the entrepreneurship course in this study sample. Purposive sampling was used to select the sample, considering the representation of programs and the number of students (Nasution, 2022). This technique allowed the researcher to select student groups based on specific criteria relevant to the research topic, ensuring that the chosen sample represented the selected population (Nasution, 2022).
The study was conducted in several stages: (a) preparation, (b) implementation, (c) data collection, and (d) data analysis. The PBL implementation syntax included (a) orientation, (b) organization, (c) planning, (d) implementation, and (e) evaluation (Shieh, 2023). In this study, AI was integrated into the media in various ways, including simulations, chatbots, and virtual reality. Problems were presented without prior reading or lectures, emphasizing the importance of self-inquiry and the integration of theory and practice (Shieh, 2023).

A rubric-assisted test was used to collect data, assessing students’ entrepreneurial skills, problem-solving, and decision-making abilities. The data analysis utilized ANCOVA to evaluate differences between the experimental and control groups, controlling for covariates that might affect the dependent variable (Shieh, 2023). ANCOVA controlled for covariates that could influence entrepreneurial skills, testing the difference in skills between the experimental and control groups.

RESULTS AND DISCUSSION

The analysis results indicate that integrating Project-Based Learning (PBL) and Artificial Intelligence (AI) in entrepreneurship education was successful. The experimental group (AI-assisted PBL) was compared with the positive control group (traditional PBL) and the negative control group (lecture-based learning).

Table 1: Data Analysis Results, Mean and Standard Deviation of Experimental and Control Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group</td>
<td>82.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Control Group</td>
<td>75.1</td>
<td>5.8</td>
</tr>
</tbody>
</table>

*Source: Processed research results*

Compared to the positive control group (traditional PBL) and the negative control group (lecture-based learning), the experimental group scored significantly higher in entrepreneurial skills (M = 82.5, SD = 6.2). This contrasts with the positive control group (M = 74.1, SD = 5.8) and the negative control group (M = 68.3, SD = 5.4).

Table 2: Test of Between-Subject Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>162.667</td>
<td>5</td>
<td>32.533</td>
<td>33.655</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>1104.133</td>
<td>1</td>
<td>1104.133</td>
<td>1142.207</td>
<td>.000</td>
</tr>
<tr>
<td>PBL</td>
<td>53.333</td>
<td>1</td>
<td>53.333</td>
<td>55.172</td>
<td>.000</td>
</tr>
<tr>
<td>AI Assistance</td>
<td>106.067</td>
<td>2</td>
<td>53.033</td>
<td>54.862</td>
<td>.000</td>
</tr>
<tr>
<td>Entrepreneurial Skills</td>
<td>3.267</td>
<td>3</td>
<td>1.633</td>
<td>1.690</td>
<td>.206</td>
</tr>
<tr>
<td>Error</td>
<td>23.200</td>
<td>94</td>
<td>.967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1290.000</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlated Total</td>
<td>185.867</td>
<td>99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The univariate analysis of variance indicates findings related to the influence of PBL and AI-assisted factors on entrepreneurial skills. The key points to note are:

1. **Influence of PBL Learning Factor.** The PBL learning factor has an F value of 1142.207, with a significance of 0.000, indicating a significant difference in entrepreneurial skills among the groups receiving various types of PBL learning. The mean square of the PBL learning factor is 55.172, meaning the differences in students' entrepreneurial skills can be explained by the different types of PBL learning received.

2. **Influence of AI-Assisted Factor.** The F value of the AI-assisted factor is 54.862, with a significance of 0.000, indicating that AI-assisted learning also significantly impacts students' entrepreneurial skills. The mean square of the AI-assisted factor is 53.033, showing that the variation in AI assistance is largely associated with students' entrepreneurial skills.

3. **Interaction Between PBL and AI-Assisted Learning.** The interaction between AI-assisted learning and PBL shows a significant effect (F value = 1.690; sig. = 0.206), indicating that these two components independently influence students' entrepreneurial abilities.

4. **Quality of the Model:** An R Squared value of 0.875 (Adjusted R Squared = 0.849) indicates that the model successfully explains approximately 87.5% of the variability in students' entrepreneurial skills. This is a strong indicator of the model's effectiveness in predicting entrepreneurial skills based on the independent variables of PBL and AI-assisted learning.

Therefore, the analysis results show that both PBL and AI-assisted learning significantly impact students' entrepreneurial skills. Moreover, the model can be used to understand elements influencing future entrepreneurial abilities.

This study demonstrates that combining PBL and AI in entrepreneurship education can significantly enhance students' entrepreneurial skills. In other words, PBL and AI can help students acquire skills such as problem-solving, entrepreneurship, and decision-making.

Other research has found that PBL and AI can improve learning outcomes in various educational fields. Previous studies have shown that PBL can enhance students' skills in problem-solving, communication, and teamwork (Prilestari, 2019). Additionally, previous research has indicated that AI can increase student engagement in learning, their motivation to learn, and their learning outcomes (Prilestari, 2019). Problem-Based Learning (PBL) is highly effective in improving students' analytical and problem-solving abilities and communication and teamwork skills (Li et al., 2022). While group dynamics in PBL can influence student
outcomes, these dynamics are less predictive of academic or behavioral outcomes, highlighting the challenge of measuring PBL’s effectiveness on teamwork skills.

Several factors could explain why the average entrepreneurial skill scores differ between the experimental, positive control, and negative control groups. One example is that PBL can help students learn entrepreneurial skills through hands-on experience in entrepreneurial projects. Recent research indicates that AI can enhance student learning through simulations, chatbots, and VR. Innovative approaches like VR and simulations can help students learn better (Wang et al., 2022). Students in the experimental group might also be more motivated to learn due to their engagement in more active and engaging learning activities.

Both PBL and AI are crucial for enhancing students’ entrepreneurial skills in the experimental group. PBL provides hands-on experience in entrepreneurial projects, and AI helps students learn more efficiently. This study supports the constructivist theory, which posits that learning is an active process where students construct their knowledge through experience. Furthermore, the findings suggest that PBL and AI can be effective approaches to entrepreneurship education by helping students acquire skills and knowledge.

The findings of this study are crucial for the practice of entrepreneurship education as they indicate that PBL and AI should be incorporated into entrepreneurship education curricula to improve student learning outcomes. Moreover, educators should be trained in using PBL and AI in entrepreneurship education. Educational institutions should provide adequate resources to support using PBL and AI in entrepreneurship education.

Integrating Project-Based Learning (PBL) and Artificial Intelligence (AI) in entrepreneurship education has several social and ethical implications that must be considered (Wardhani et al., 2018; Yogyakarta, 2012). It can provide better access to entrepreneurship education for students who may lack conventional resources, such as teachers and classrooms (Ismawati, 2018). This can help reduce economic and social disparities and provide more equitable opportunities for entrepreneurial learning (Asyari, 2014). However, it is important to remember that existing digital divides can be exacerbated by a lack of access to digital technology. If students do not have access to computers or the internet, they may be unable to fully participate in PBL and AI activities, putting them at a disadvantage.

Ensuring that AI is used ethically and responsibly in entrepreneurship education is crucial. While AI can enhance educational experiences and administrative efficiency, it should not be used to discriminate against or oppress students (Lopes et al., 2022). Additionally, AI should not track or monitor students without their consent. Student data must be protected when using PBL and AI in entrepreneurship education (Hatammimi & Nuraifah, 2023). Data privacy regulations must be followed when collecting, storing, and using student data. While PBL and AI can be beneficial in entrepreneurship education, it is important to
remember that technology should not replace the human role. Human mentors and educators still play a crucial role in guiding, supporting, and providing feedback to students.

CONCLUSION

This study found that incorporating Project-Based Learning (PBL) and Artificial Intelligence (AI) into entrepreneurship education can significantly enhance students’ entrepreneurial skills. The results indicate that PBL and AI can be used to help students acquire the necessary skills to become successful entrepreneurs, which has important implications for the practice of entrepreneurship education. However, there are several limitations to this study that must be considered, including the small sample size, the quasi-experimental design, and the limitations of the measurement instruments. Further research is needed to address these limitations and to gain a better understanding of how PBL and AI function in entrepreneurship education.

The integration of PBL and AI in entrepreneurship education has the potential to improve student learning outcomes and provide more equitable opportunities for entrepreneurship education for all students. However, it is important to consider the social and ethical consequences of using these technologies to ensure responsible and ethical usage.

Based on the results and limitations of this study, the following recommendations are made for practice and future research: (a) provide adequate resources to support the implementation of PBL and AI, (b) conduct research with larger and more representative samples, (c) use more robust experimental designs, and (d) develop more valid and reliable measurement instruments.

Further research on these recommendations and the development of this theme can enhance our understanding of how to effectively combine PBL and AI in entrepreneurship education. Additionally, this can lead to the development of better educational practices that help students acquire the skills and knowledge necessary to become successful entrepreneurs.

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