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The Impact of Artificial Intelligence AI in Team-Based Project TBPj on Undergraduate Students' Meta-skills

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Abstract: The rapid transformation of the world due to advances in science and technology encourages universities to develop students' meta-skill competencies to adapt to various changes in world work. This research aims to investigate the impact of artificial intelligence (AI) integrated team-based project (TBPj) on the development of undergraduate students' meta-skills. This study employed a quasi-experimental design using one group pre-test and post-test design with 30 research subjects. Data were collected using a meta-skills instrument in the form of a questionnaire and analyzed using a paired sample t-test. The results revealed a significant difference between the mean meta-skill scores of the students before (M = 37.50, SD = 13.31) and after (M = 86.57, SD = 4.30) the treatment [t(36) = 13.884, p < 0.001; d = 4.20]. Based on the results, it can be concluded that the use of AI integrated with the TBPj model has a high impact on improving undergraduate students' meta-skills.

Keywords: artificial intelligence AI, team-based project TBPJ, meta-skills

Abstrak: *Cepatnya transformasi dunia akibat kemajuan ilmu pengetahuan dan teknologi mendorong perguruan tinggi untuk mengembangkan kompetensi meta-skills mahasiswa agar lebih adaptif terhadap berbagai perubahan dunia kerja. Penelitian ini bertujuan untuk mengetahui pengaruh penerapan artificial intelligence (AI) terintegrasi team-based project (TBPj) terhadap pengembangan meta-skills mahasiswa. Studi ini adalah quasi eksperimen menggunakan rancangan one group pre-test and post-test design dengan subjek penelitian sebanyak 30 orang. Data dikumpulkan dengan menggunakan instrument meta-skills berbentuk kuisioner dan dianalisis menggunakan uji statistic paired sample t-test. Hasil penelitian menunjukkan perbedaan signifikan antara rata-rata skor meta-skills mahasiswa sebelum (M = 37.50, SD = 13.31) dan setelah (M = 86.57, SD = 4.30) perlakuan [t(36) = 13.884, p <0.001; d = 4,20]. Berdasarkan hasil tersebut dapat disimpulkan bahwa penggunaan AI terintegrasi model TBPj berdampak tinggi terhadap perbaikan meta-skills mahasiswa*

Kata kunci: *artificial intelligence AI, team-based project TBPJ, meta-skills*

▪ INTRODUCTION

The rapid advances in knowledge and technology have led to an ever-changing landscape in which no one can predict the future of work. Many jobs are disappearing or being recreated, while new jobs are being created at an unparalleled rate. Indeed, some studies indicate that approximately 65% of the current student population will be employed in occupations that are not yet in existence (Mitchell, 2021). Higher education needs to respond to this and equip undergraduate students with the necessary skills to thrive in an increasingly rapidly changing and unpredictable future. Undergraduate students need skills not only to face change but also to thrive in it, take advantage of new things, and create change for themselves.

One of the skills that supports individual adaptability to change is meta-skills. Meta-skills are high-order skills that stimulate adaptability and enable individuals to thrive in a

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constantly evolving world, thereby promoting success in all contexts (The Scottish Funding Council, 2019; The Skills Development Scotland, 2021). These skills are deemed to be a critical characteristic of the 21st century that cultivates growth mindsets and attitudes that foster a love for learning and problem-solving, as well as the development of new and challenging competencies, resulting in lifelong learning that prepares individuals for the ever-changing landscape (Prasittichok & Klaykaew, 2022; Senova, 2020).

Individuals who possess good self-management, social intelligence, and innovation skills are said to have excellent meta-skills (Jassal, 2018; Mitchell, 2021; Yadollahi & Yazdani, 2020). These skills enable them to effectively navigate an ever-changing world by embracing new ideas, adopting a flexible mindset, and continually seeking knowledge (Mandro, 2022). Basically, meta-skills are innate talents that individuals use to explore and understand their surroundings. It serves as a fundamental building block for the development of technical and transferable skills (Barkas et al., 2021; Mitchell, 2021). As the level of education increases, it is crucial for educators to nurture and enhance the meta-skills of their students, as they will need these skills to confront the complex and unpredictable world ahead. Thus, higher education practitioners must prioritize the growth of their students' meta-skills.

Unfortunately, research on student meta-skills in Indonesia, particularly at Jambi University, is still limited. A preliminary study conducted on 84 fifth-semester undergraduate students of the Biology Education Program at Jambi University found that the meta-skills of the students were still low. This is reflected in the submission of assignments which are often late and lack focus on completing them, indicating that self-management is still lacking. Additionally, students prefer to work individually rather than collaborate, as demonstrated by their behavior when given group assignments, only some members participate in completing the assignment, indicating that social intelligence is still low. Furthermore, prospective teacher students are still confused about the transition from the 2013 curriculum to the independent curriculum, which is marked by failures in creating learning tools and administrations in the independent curriculum. They are also confused about facing various learning problems and challenges in the independent curriculum, indicating that their critical thinking skills, problem-solving skills, and innovation are still low. This underscores the importance of developing students' meta-skills through learning innovation.

Many studies have stated that project-based learning (PjBL) is useful in improving problem solving (Jaenudin et al., 2020; Karan & Brown, 2022), critical thinking (Aristin & Purnomo, 2022; Desiana et al., 2022), creative thinking (Cahyani, 2021; Handayani et al., 2023; Jaenudin et al., 2020), and innovative thinking (Artama et al., 2023; Asbjornsen, 2015). However, most PjBL research is still implemented individually, and there is no technology integration. The application of individual project-based learning can lead to student innovation but not social intelligence and self-management. In line with this information, it is necessary to conduct research on the integration of technology into team-based project to develop students meta-skills.

Artificial Intelligence (AI) technology has the potential to significantly enhance the educational experience of prospective biology teachers, particularly with regard to meta-skills development. By utilizing AI, teachers can concentrate on designing tailored instruction that caters to the needs and learning styles of students through personalized

learning (Mambu et al., 2023; Zawacki-Richter et al., 2019). The integration of AI into education enables educators to develop learning tools that are well-suited to the independent curriculum that involves differentiated learning (Celik et al., 2022). It promotes the adaptability and problem-solving skills of prospective teachers in facing teacher challenges in the independent curriculum (Abbas & Hussain, 2021). Previous studies also state that AI is a valuable tool for teachers in the digital age (Tahiru, 2021; Zahara et al., 2023). The utilization of AI can increase efficiency, provide personalized learning, offer effective feedback, improve teaching effectiveness, and prepare students to navigate the increasingly tech-driven world (Baidoo-anu & Ansah, 2023; Zafari et al., 2022; Zhai et al., 2021). In summary, the implementation of AI in education fosters students' meta-skills, making them adaptable and responsive to the changes in the educational landscape influenced by technology.

Integration of AI technology into team-designed project-based learning can foster the development of students' meta-skills. In this study, students were organized into teams to work together on complex projects. The project was created to address the challenges faced by prospective teachers in developing learning tools in the era of an independent curriculum through the utilization of AI technology. Undergraduate students were granted the freedom to identify learning problems, design projects as solutions, and implement these projects using AI. This learning activity is anticipated to encourage the growth of meta-skills, such as problem-solving, critical thinking, creativity, collaboration, communication, sense-making, leadership, team management, and adaptation to change. This aligns with previous research which has shown that project-based learning can improve problem-solving and critical thinking (Guo et al., 2020; Matahari et al., 2023) and creative thinking (Erisa et al., 2021; Rahardjanto et al., 2019; Yanti & Novaliyosi, 2023), and that project-based learning carried out as a team leads to more active student participation in processing and synthesizing information, considering multiple perspectives, combining ideas and opinions, and articulating their points, resulting in a more comprehensive understanding and improved collaboration and communication skills (Alfaeni et al., 2022; Handrianto & Rahman, 2019; Tekad & Pebriana, 2022).

Based on the explanation above, team-based project has the potential to improve undergraduate students' meta-skills in terms of social intelligence and innovation, while the use of AI in learning has the potential to improve meta-skills in terms of self-management and innovation. As such, this study aimed to determine the impact of AI-integrated team-based project on undergraduate students' meta-skills. This research needs to be conducted to provide valuable information to education practitioners regarding the implementation of AI-integrated team-based project models as a means to develop meta-skills in undergraduate students, which are crucial for success in a dynamic and ever-evolving world.

▪ METHOD

This study is quasi-experimental research with a one-group pre-test and post-test design (Subali, 2019), as shown in Table 1. The independent variable in this study is the AI-integrated team-based project model and the dependent variable is students' meta-skills.

Table 1. Research design

Class	Pre-Test	Treatment	Post-Test
Experiment	O_1	X_1	O_2

Description:
X_1: Implementation of AI in TBPj
O_1: Test before implementation of AI in TBPj
O_2: Test after implementation of AI in TBPj

The present research comprised three primary stages: 1) an initial assessment of meta-skills prior to the implementation of treatment; 2) the implementation of AI-integrated TBPj, which involved grouping students, presenting essential questions related to teachers' demands and problems in managing learning which can be resolved through the use of AI, devising a project plan, creating a schedule, monitoring progress, evaluating the outcome, and assessing the overall experience; and 3) a final assessment of meta-skills following the implementation of treatment.

The population in this study comprised biology education students at Jambi University in the 2023/2024 academic year. The sample selection was conducted using a purposive sampling technique. Utilizing this technique, the research sample comprised 30 biology education students of Jambi University enrolled in elective courses in AI in biology learning during the aforementioned academic year.

The data in this study were the meta-skills of undergraduate students before (pre-test) and after (post-test) the implementation of the AI-integrated TBPj in their learning process. Meta-skills assessment was undertaken using a non-test instrument in the form of a questionnaire comprised of 79 statement items. This questionnaire was designed to evaluate the meta-skills domain: 1) self-management: focusing, adapting, integrity, and initiative; 2) social intelligence: communicating, feeling, collaborating, and leading; and 3) innovation: curiosity, creativity, sense-making, and critical thinking (Jassel, 2018; The Skills Development Scotland, 2021; Mitchell, 2021; Spencer & Lucas, 2021). The self-management domain consists of 25 statement items, while the social intelligence domain includes 27 statement items, and the innovation domain has 27 statement items. This instrument was adapted from research conducted by Mardiyanti & Siburian (2023), which was deemed valid based on Pearson correlation ($p < 0.05$) and reliable based on Cronbach's Alpha α (0.99) > 0.60.

The data were analyzed using prerequisite tests and hypothesis tests using SPSS Statistics software version 25. The prerequisite test was the Shapiro-Wilk normality test and the hypothesis test was paired sample t-test. The effect size score for the t-test represents the magnitude of the impact implementation of AI-integrated TBPj on students' meta-skills, as interpreted based on the criteria in Table 2 (Becker, 2000; Ellis, 2010).

Table 2. Effect size criteria for the t-test (Cohen's d)

No	Cohen's d	Effect Size
1	0.2 – 0.4	Low
2	0.5 – 0.7	Medium
3	≥ 0.8	High

▪ RESULT AND DISSCUSSION

In a formal tone, learning in higher education refers to an outcome-based education (OBE) curriculum to foster the development of graduates who can adapt to the ever-changing demands of the work and industrial sectors. One of the critical competencies that undergraduate students must acquire is meta-skills. These skills enable them to be versatile and responsive to addressing the complexities of the 21st century, which is dominated by science and technology. In this regard, this study examines the impact of implementing an artificial intelligence-integrated team-based project to improve the meta-skills of prospective biology teacher students. The meta-skills data of undergraduate students before and after the implementation of the AI-integrated team-based project are depicted in Figure 1.

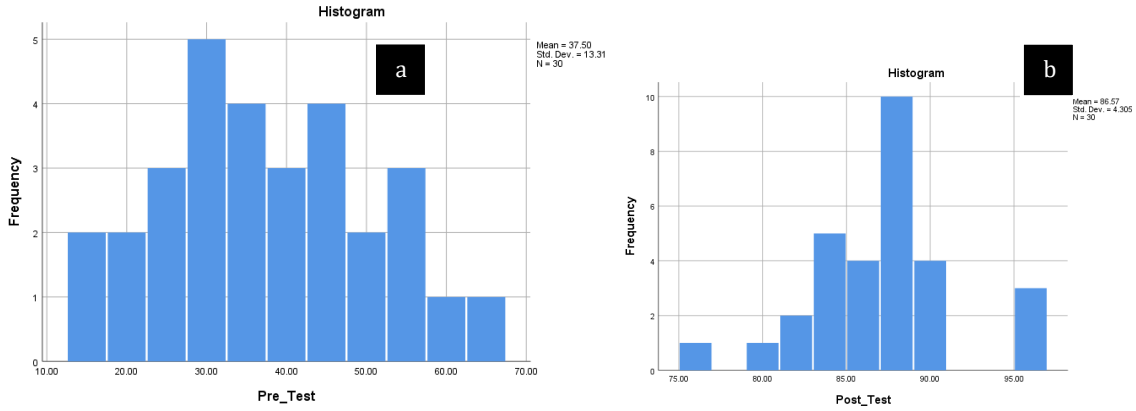

Figure 1. The distribution of student meta-skill scores: a) pre-test and b) post-test

Descriptive statistics presented in the graphic provided information regarding the meta-skill scores of 30 students before and after using AI in TBPj. The results indicated that the mean meta-skill score of students before treatment was 37.50 (SD = 13.31), while the mean score after treatment was 86.57 (SD = 4.30). This suggests a significant difference between the meta-skill scores of students before and after treatment, with an average difference of 49.07. Before testing the hypothesis, a normality test was conducted on the difference between students' pre-test and post-test meta-skills scores using SPSS software version 25. The results of the Shapiro-Wilk test suggest that the data regarding student meta-skills follow a normal distribution [W (30) = 0.95, p = 0.77]. Given this finding, parametric statistics (paired sample t-test) were employed to analyze the meta-skills scores.

Table 3. The result of the paired sample t-test

Data	t	df	Sig. (2-tailed)	Explanation
Meta-skills score	-23.028	29	0.001	Significant

The results presented in Table 3 indicate that a significant discrepancy exists between the mean meta-skill scores of students prior to (M = 37.50, SD = 13.31) and following (M = 86.57, SD = 4.30) treatment [t(36) = 13.884, p < 0.001]. These findings suggest that the application of AI in TBPj has an impact on the meta-skills of

undergraduate students. The magnitude of this influence was quantified using Cohen's d score, which is shown in Table 4.

Table 4. The category of meta-skills improvement

Data	Cohen's d	Effect Size
Meta-skills score	4.20	High

Based on the data presented in Table 4, the value of Cohen's d is 4.20, suggesting that the integration of artificial intelligence in team-based project has a high impact on improving the meta-skills of undergraduate students. Artificial intelligence (AI) is a term used to describe computer programs designed to imitate human intelligence, including decision-making abilities, logic, and other intelligence characteristics (Heeg & Avraamidou, 2023). AI systems can perform one of the following four forms of intelligence: acting humanly (AI systems can act like humans), thinking humanly (AI systems can think like humans), thinking rationally (AI systems have the ability to think rationally), or acting rationally (AI systems have the ability to act rationally) (Boucher, 2020). Project-based learning (PjBL) is a learning model that involves students in the construction of knowledge through the completion of meaningful projects and the development of real-world products (Guo et al., 2020). In this study, students were introduced to AI technology and its application in education. Specifically, they were directed to explore the challenges and problems of learning in the context of an independent curriculum and then design AI-based projects as solutions. Project-based learning is carried out in teams (TBPj), where students collaborate to solve real-world problems by creating products as solutions.

The findings in this study indicate that the implementation of AI-integrated TBPj has a high impact on improving undergraduate student meta-skills, which is in line with several previous reports that examined almost the same learning design. Several previous studies have reported that the use of AI has had a positive impact on teacher management in managing learning administration; for example, planning and assessing learning and providing innovative media and teaching materials according to student needs (Cardona et al., 2023; Igbokwe, 2023; Saputra et al., 2023; Sok & Heng, 2023; Zawacki-Richter et al., 2019). Moreover, the application of AI in learning equips prospective teachers with the ability to adapt to technological advancements as a means of creatively addressing learning challenges (Chen et al., 2020; Heeg & Avraamidou, 2023; Zhai et al., 2021). On the other hand, Siddiqui & Srivastava (2021) and Zakiah & Fajriadi (2020) reported that project-based learning can improve self-management skills in independent learning. Additionally, other studies have demonstrated that project-based learning can enhance problem-solving and critical thinking (Jeniver et al., 2023; Matahari et al., 2023), creative thinking (Deria et al., 2023; Fadhilah et al., 2023), and metacognitive skills (Lukitasari et al., 2021; Rumahlatu & Sangur, 2020). Moreover, project-based learning conducted in teams can improve collaboration, leadership, and communication skills (Almulla, 2020; Hasanah et al., 2023; Maros et al., 2023; Undari et al., 2023). The improvements in the skill achievements described represent sublevel competencies in the meta-skills domain.

Meta-skills are high-level skills that foster adaptability and promote individual success in various situations. The mastery of meta-skills equips individuals to thrive in the dynamic landscape of the workforce (Mandro, 2022; Senova, 2020). The domain of

meta-skills include self-management (managing the now), social intelligence (connecting with the world), and innovation (creating our own change). These three competencies are interrelated, and support the development of other skills. For instance, individuals require the ability to focus on a problem, which facilitates the emergence of creativity and innovation as a solution. Then, they need the initiative to implement these ideas (Jassal, 2018; The Skills Development Scotland 2021; Spencer & Lucas, 2021).

The first domain of meta-skills is self-management, which is essential for addressing ongoing changes and enhancing performance and productivity (Spencer & Lucas, 2021). These skills include focusing, integrity, adaptation, and initiative. Focusing refers to managing the cognitive load by filtering information to maintain a sense of focus in an era of information overload and constant change. Integrity involves acting in accordance with ethical and fair principles. Adaptation refers to the willingness and ability to continuously expand knowledge, understanding, and skills to remain adaptive and resilient to changing circumstances. The initiative refers to being ready to initiate and act on opportunities based on self-confidence (Jassal, 2018; The Skilss Development Scotland, 2021). The implementation of AI-integrated TBPj can train these skills, where through analysis of learning problems and challenges in the era of the independent curriculum, undergraduate students indirectly have to focus on filtering and selecting relevant information. Adaptive skills are also developed in this case, they must expand their knowledge, understanding, and skills in utilizing AI technology as a solution and develop initiatives to design and implement the project. Additionally, students must understand the moral and legal implications of the use of AI in education to maintain academic values and norms in their actions as a form of integrity.

The second domain of meta-skills is social intelligence, encompassing skills that enable individuals to effectively navigate and negotiate complex social and environmental relationships (Spencer & Lucas, 2021). Sub-skills within this domain include communicating, Feeling, collaborating, and leading. Communicating pertains to the open and honest exchange of information to create a shared understanding among all parties involved. Feeling involves considering the impact on others by taking into account diverse thoughts, feelings, and perspectives. Collaborating involves working with others to convey information or solve problems while leading involves taking responsibility for a task and influencing others through inspiration, motivation, and persuasion (Jassal, 2018; The Skilss Development Scotland, 2021). The development of these skills can be facilitated through the integration of AI in TBPj in the learning process, where students actively collaborate among members to complete projects that have been planned as a solution to learning challenges in the era of an independent curriculum. This collaboration involves collecting and synthesizing information, reframing ideas, and considering other group members' perspectives, which enhances students' empathy and communication skills. Furthermore, activities such as exchanging data, debating, providing feedback, and answering questions between group members also improve undergraduate students' leading and decision-making skills.

The third domain of meta-skills is innovation, which encompasses the skills and abilities necessary to initiate change rather than passively respond to it (Spencer & Lucas, 2021). Sub-level innovation skills include curiosity, creativity, sense-making, and critical thinking. Curiosity refers to the desire to learn something to discover new ideas. Creativity involves the skills to imagine and think of new ways of solving problems,

answering questions, or expressing meaning. Sense-making refers to the ability to understand and make sense of complex information, and critical thinking involves the ability to evaluate and analyze information to make informed decisions (Jassal, 2018; The Skilss Development Scotland, 2021). In the context implementation of AI-integrated TBPj in the learning process, undergraduate students engage in a range of activities aimed at developing these innovation skills. For example, they make observations, ask questions, and seek out sources of information to gain a deeper understanding of the challenges faced by teachers in the era of the independent curriculum. They also study and explore the benefits of AI in education, seeking out alternative solutions to previously identified problems. The information collected is then analyzed as a basis for finding new, more effective ways and implemented in projects as solutions to previously identified problems. Through planning and implementing team projects that rely on AI technology, students develop the ability to create learning plans, assessment instruments, media, and teaching materials that are tailored to students' needs to achieve holistic learning goals. During this process, students demonstrate high levels of curiosity, sense-making, creativity, and critical thinking.

In light of the description provided, AI-integrated TBPj holds significant relevance for the needs of prospective biology teacher students in cultivating essential meta-skills. This learning design imparts a comprehensive understanding of AI technology, which has become increasingly crucial in contemporary education. Prospective biology teacher students are equipped to be adaptive and proffer solutions to teachers' pedagogical demands in designing, implementing, and evaluating learning experiences through the utilization of AI technology. Consequently, teachers are able to concentrate more on interacting and shaping the character of students. Furthermore, through TBPj, undergraduate students learn to collaborate, communicate, and solve problems creatively and effectively. This approach enables students to become self-reliant in their learning and take responsibility for their own education, which is an important aspect of fostering independent and critical thinking in biology teachers. Therefore, TBPj integrated with AI constitutes a potent learning method that can aid prospective biology teacher students in developing pertinent meta-skills and empower them as effective educators.

▪ CONCLUSION

In this study, the impact of AI-integrated TBPj on students' meta-skills was studied. Conclusive evidence indicate that the AI-integrated TBPj model has a high impact on the development of meta-skills among undergraduate students [$t(36) = 13.884$, $p < 0.001$; $d = 4.20$]. The use of AI in TBPj trains prospective teachers to be adaptive and responsive to technological advances as a tool for innovatively solving learning problems. The incorporation of AI within TBPj also supports students in focusing on resolving learning management issues, and requires teachers to employ technology while engaging in critical, creative, innovative, communicative, and collaborative thinking. These practices ultimately led to the enhancement of undergraduate students' meta-skills. The results of this research show that AI-integrated TBPj serves as a viable alternative learning model that is relevant to the dynamic and evolving nature of the contemporary workplace. Further research is warranted to evaluate the implementation of AI-integrated TBPj on other skills and to uncover additional positive outcomes associated with the model.

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