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Understanding Biology Pre-service Teachers' Acceptance of PjBL e-logbook: An Application of the UTAUT Model at Universitas Jambi

Jodion Siburian[1], M. Erick Sanjaya[2], Ine Tentia[3], Raissa Mataniari[4], Dian Arisandy Eka Putra Sembiring[5*]

[1,2,3,4,5]Program Studi Pendidikan Biologi, PMIPA, FKIP, Universitas Jambi, Jambi, Indonesia

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ABSTRACT

This study investigates factors influencing biology education students' acceptance and use of a Project-Based Learning (PjBL) e-logbook at Universitas Jambi using the Unified Theory of Acceptance and Use of Technology (UTAUT). The PjBL e-logbook was implemented in core courses of the Biology Education Study Program to support structured documentation, monitoring, and reflection on project work. An explanatory survey design was employed with 130 undergraduate biology education students who had used the e-logbook for at least four weeks. Data were collected using a UTAUT-based questionnaire covering performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), behavioral intention (BI), and the PjBL e-logbook use behavior (UB). Partial least squares structural equation modeling (PLS-SEM) was used to assess the measurement and structural models. The results show that PE (β = 0.38, $p < .001$), EE (β = 0.21, p = .018), and SI (β = 0.16, p = .049) significantly predict BI, whereas FC has a positive but non-significant effect on BI (β = 0.11, p = .148). Together, these UTAUT constructs explain 52% of the variance in BI. BI strongly predicts the PjBL e-logbook use behavior (β = 0.56, $p < .001$), and FC also has a modest direct effect on UB (β = 0.19, p = .028), with the model explaining 39% of the variance in UB. The findings highlight the central role of perceived usefulness, ease of use, and social influences in promoting intention, and confirm the importance of both intention and facilitating conditions for actual e-logbook use. Practical implications are discussed for designing and scaling PjBL e-logbooks in teacher education at Universitas Jambi and similar institutions.

Corresponding Author: dianarisandys@unja.ac.id

INTRODUCTION

Project-Based Learning (PjBL) has been widely adopted in teacher education to foster higher-order thinking, collaboration, and 21st-century skills (Sadikin et al., 2024a, 2024b). In the Biology Education Study Program at Universitas Jambi, PjBL is integrated into several core courses that require students to design, implement, and evaluate mini-projects and teaching practices. However, a persistent challenge in these courses is how to systematically monitor and document students' project processes, reflections, and artefacts over multiple weeks.

Digital or electronic logbooks (e-logbooks) offer a promising solution by enabling continuous documentation, reflection, and feedback in PjBL environments. A PjBL e-logbook can help biology education students plan project activities, track progress, record challenges, and reflect on their learning, while also providing lecturers with richer data for formative assessment. The successful integration of such tools, however, depends on students' acceptance and sustained use.

To understand technology acceptance in educational contexts, the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003; Venkatesh et al., 2012) has been widely applied. UTAUT posits that behavioral intention (BI) and use behavior (UB) are determined by four core constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). In the original formulation, PE, EE, and SI primarily predict BI, while FC, together with BI, predicts UB. Recent studies in education and emerging technologies (Almaiah et al., 2019; Li et al., 2022; Habibi et al., 2024; Pan & He, 2024) confirm the robustness of this framework across contexts such as mobile learning, blended learning, flipped classrooms, and AI-based tools.

In the context of a PjBL e-logbook for biology education students at Universitas Jambi, PE reflects the degree to which students believe the e-logbook helps them work more efficiently, improve the quality of their work, enhance creativity, and reduce their workload. EE captures how easy it is to learn and use the e-logbook, including the clarity and simplicity of the interface and the steps. SI captures perceived expectations and support from peers and lecturers to use the e-logbook, as well as the perception that using the e-logbook is part of current and future professional practice. FC reflects the availability of hardware, software, time, and training resources needed to use the e-logbook. BI represents students' intention to continue using and recommending the e-logbook, and the PjBL e-logbook use behavior denotes actual use and compliance with e-logbook activities over time.

Despite the growing literature on UTAUT in higher education, there is limited evidence on its application to PjBL e-logbooks in teacher education, particularly in the Indonesian context. At Universitas Jambi, the PjBL e-logbook is relatively new, and empirical evidence is needed to understand the factors that support or hinder its adoption among students in biology education.

LITERATURE REVIEW

Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT was proposed by Venkatesh et al. (2003) as an integrative model synthesizing eight earlier technology acceptance theories. UTAUT argues that PE, EE, and SI influence BI, whereas BI and FC directly influence UB (Venkatesh et al., 2003). UTAUT2 later

extended the model to consumer contexts by adding constructs such as hedonic motivation, price value, and habit (Venkatesh et al., 2012).

In higher education, UTAUT and its extensions have been applied to explain the acceptance of mobile learning systems (Almaiah et al., 2019), blended learning (Li et al., 2022), LMSs (Al-Adwan et al., 2022), micro-lectures (Wijaya et al., 2022), and flipped classrooms (Pan & He, 2024). Across these studies, PE often emerges as the strongest predictor of BI, followed by EE and SI, while FC tends to have a stronger direct effect on UB than on BI.

Recent research on AI tools in education also relies on UTAUT or UTAUT2. For example, Habibi et al. (2024) used a combined UTAUT2 and TPB framework to explain ChatGPT acceptance among Indonesian university students, confirming that BI was the most robust predictor of actual use. These findings justify the use of UTAUT to examine acceptance of the PjBL e-logbook among biology education students at Universitas Jambi.

UTAUT in higher education and AI-related tools

Several studies have examined the acceptance of technology in higher education using UTAUT-based models. Almaiah et al. (2019) showed that information quality, compatibility, trust, awareness, and availability of resources significantly influenced students' acceptance of mobile learning in higher education. Li et al. (2022) found that social influence, facilitating conditions, perceived enjoyment, self-management, and self-efficacy were significant predictors of blended learning acceptance among secondary vocational students.

In the context of AI tools, Habibi et al. (2024) demonstrated that UTAUT2 constructs such as performance expectancy, effort expectancy, and social influence, combined with TPB components, significantly explained the acceptance and use of ChatGPT in Indonesian universities. Pan and He (2024) used UTAUT and learning engagement theory to investigate flipped classrooms and found that performance expectancy, effort expectancy, and peer influence significantly enhanced learning engagement and capabilities.

These studies suggest that UTAUT is suitable for explaining students' acceptance of a variety of technologies, including those supporting PjBL and AI-enhanced learning. In this study, we adopt the original UTAUT structure—focusing on PE, EE, SI, FC, BI, and UB—to investigate acceptance of the PjBL e-logbook among biology education students at Universitas Jambi.

Technology Integration in PjBL

A second strand of literature relevant to this study concerns the integration of digital and AI technologies in PjBL environments. Across disciplines, technology-enhanced PjBL has been shown to improve collaboration, engagement, creativity, and learning outcomes. Rattanakha et al. (2025) examined AI-powered smart classrooms for collaborative PjBL and reported that mobile and virtual learning technologies increased collaboration, motivation, and learning outcomes. Dinger et al. (2024) found that integrating AI into project-based curricula in digital entrepreneurship enhanced creativity, digital skills, and learning outcomes. In medical education, Wang (2025) showed that integrating three-dimensional

visualization reconstruction technology into problem-based learning improved clinical understanding and satisfaction.

More specific tools have also been investigated. Kumar (2021) reported that educational chatbots in PjBL design courses improved collaboration, motivation, and learning outcomes. He et al. (2025) found that virtual reality interactivity increased engagement and creativity in PjBL contexts. Benlaghrissi and Ouahidi (2024) showed that mobile-assisted PjBL was more effective than traditional methods in improving EFL speaking skills. Sisamud et al. (2025) demonstrated that PjBL on metaverse platforms, combined with design thinking, fostered creativity and innovation. Purnama et al. (2023) synthesized evidence indicating that integrating GPT-based tools into PjBL improved learning outcomes and student engagement. Broader reviews (Jiang et al., 2025; Ruiz Viruel et al., 2025) and empirical work (Baek, 2025; Ghazali et al., 2025) suggest that AI-enhanced PjBL can support social interaction, 4C skills, and learner autonomy when well designed.

In the biology education study program at Universitas Jambi, the PjBL e-logbook is part of a broader ecosystem of technologies that scaffold PjBL processes. Although the e-logbook itself is not an AI engine, it supports planning, monitoring, and reflection, and can be integrated with other digital or AI tools used in coursework.

Linking back to UTAUT studies in e-learning and blended learning (Almaiah et al., 2019; Abdou & Jasimuddin, 2020; Li et al., 2022; Wijaya et al., 2022; Al-Adwan et al., 2022; Patil & Undale, 2023), the success of such technology integration depends on students' perceptions of usefulness, ease of use, social support, and adequate facilitating conditions. In our study, we apply this logic to understand how biology education students at Universitas Jambi adopt the PjBL e-logbook.

METHODS

Research Design and Context

This study employed a quantitative explanatory survey design. The research was conducted in the Biology Education Study Program, Faculty of Teacher Training and Education, Universitas Jambi, Indonesia. In this program, PjBL is integrated into several core courses, such as Microteaching, Biology Learning Media, and School-based Project courses, which require systematic documentation of project activities. To support this need, a web-based PjBL e-logbook was introduced as part of the course requirements. The logbook was used for at least one semester and served as the primary platform for documenting project planning, weekly progress, and reflections.

Participants

The target population consisted of undergraduate students in biology education at Universitas Jambi who were enrolled in PjBL-oriented courses in 2025 and had used the PjBL e-logbook for at least 4 weeks. Using a total sampling approach within the participating courses, 133 students completed the questionnaire. Participation was voluntary, and students were informed that their responses would be kept confidential and would not affect their course grades.

The PjBL e-logbook and Its Implementation

The PjBL e-logbook was developed as a simple web-based platform accessible via laptop or smartphone, with features that supported project planning (setting goals, schedules, and task distribution), weekly activity logs (documenting activities, progress, and

obstacles), reflection prompts (encouraging students to reflect on what they learned and how they collaborated), and lecturer feedback (providing space for comments and suggestions). Lecturers in the Biology Education Study Program introduced the e-logbook at the beginning of the semester, provided basic training on its use, and integrated logbook completion into course assessments. Students were asked to update their logbooks weekly in line with project milestones, while lecturers periodically reviewed the entries and discussed them during class or consultation sessions.

Instrumentation

The questionnaire was developed based on the UTAUT framework (Venkatesh et al., 2003; Venkatesh et al., 2012) and prior studies on technology and AI tool acceptance in education (Almaiah et al., 2019; Li et al., 2022; Habibi et al., 2024; Wijaya et al., 2022; Al-Adwan et al., 2022). It comprised six reflective constructs: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Behavioral Intention (BI), and The PjBL e-logbook use behavior (UB). All items were adapted and contextualized to the PjBL e-logbook at Universitas Jambi and measured using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). PE and EE were each measured by four items adapted primarily from Venkatesh et al. (2003, 2012) and Tian et al. (2025). SI was measured by four items adapted from Venkatesh and Bala (2008), Thong et al. (2006), and Tian et al. (2025). FC was measured by three items adapted from Venkatesh et al. (2012) and Tian et al. (2025). BI was measured by three items adapted from Büttner (2025), Dai et al. (2025), and Tian et al. (2025). UB was measured by four items adapted from Habibi et al. (2023).

Data Analysis

Data were analyzed using partial least squares structural equation modeling (PLS-SEM). The analysis followed a two-step procedure comprising measurement model and structural model assessment. For the measurement model, indicator reliability was examined through standardized factor loadings (> 0.70), internal consistency was evaluated using Cronbach's alpha and composite reliability (CR > 0.70), convergent validity was assessed via average variance extracted (AVE ≥ 0.50), and discriminant validity was checked using the Heterotrait–Monotrait ratio (HTMT < 0.85) (Hair *et al.*, 2022; Hair *et al.,* 2019). For the structural model, path coefficients (β) and their significance were estimated using bootstrapping, coefficients of determination (R^2) were calculated for BI and UB, and the direct effects were interpreted in line with the UTAUT framework, with PE, EE, SI, and FC specified as predictors of BI, and BI and FC specified as predictors of The PjBL e-logbook use behavior.

FINDINGS AND DISCUSSION

Findings

Measurement model

All standardized factor loadings were above 0.70, indicating satisfactory indicator reliability (Table 1). Composite reliability (CR) values ranged from 0.86 to 0.90, and Cronbach's alpha coefficients were above 0.80, demonstrating good internal consistency. AVE values ranged from 0.63 to 0.75, exceeding the recommended threshold of 0.50, thus supporting convergent validity. Discriminant validity was supported, with all HTMT values below 0.85.

Table 1. Measurement model: standardized loadings, CR, and AVE

Construct / Indicator	Loading	CR	AVE
Performance Expectancy (PE)		0.89	0.67
PE1	0.81		
PE2	0.86		
PE3	0.84		
PE4	0.78		
Effort Expectancy (EE)		0.88	0.65
EE1	0.82		
EE2	0.85		
EE3	0.79		
EE4	0.80		
Social Influence (SI)		0.87	0.63
SI1	0.80		
SI2	0.83		
SI3	0.78		
SI4	0.79		
Facilitating Conditions (FC)		0.86	0.67
FC1	0.82		
FC2	0.84		
FC3	0.79		
Behavioral Intention (BI)		0.90	0.75
BI1	0.86		
BI2	0.89		
BI3	0.84		
The PjBL e-logbook use behavior (UB)		0.89	0.68
UB1	0.82		
UB2	0.86		
UB3	0.81		
UB4	0.80		

Structural Model

The UTAUT-based structural model showed that PE, EE, and SI significantly predicted BI, whereas FC did not. PE exerted the strongest effect on BI ($\beta = 0.38$, $t = 4.92$, $p < .001$), followed by EE ($\beta = 0.21$, $t = 2.37$, $p = .018$) and SI ($\beta = 0.16$, $t = 1.98$, $p = .049$). The path from FC to BI was positive but non-significant ($\beta = 0.11$, $t = 1.45$, $p = .148$). Together, PE, EE, SI, and FC explained 52% of the variance in BI ($R^2 = 0.52$). BI, in turn, had a strong positive effect on the PjBL e-logbook use behavior (UB; $\beta = 0.56$, $t = 7.83$, $p < .001$). FC also had a modest direct effect on UB ($\beta = 0.19$, $t = 2.21$, $p = .028$). The model accounted for 39% of the variance in UB ($R^2 = 0.39$), indicating moderate explanatory power (Table 2).

Table 2. Structural model results (PLS-SEM)

Path	β	t-value	p-value	Result
PE → BI	0.38	4.92	< .001	Supported
EE → BI	0.21	2.37	.018	Supported
SI → BI	0.16	1.98	.049	Supported (weak)
FC → BI	0.11	1.45	.148	Not supported
BI → UB	0.56	7.83	< .001	Supported
FC → UB	0.19	2.21	.028	Supported (mod.)

Discussion

This study applied the UTAUT model to explain biology education students' acceptance and use of a PjBL e-logbook at Universitas Jambi. The results show that PE, EE, and SI significantly predict BI to use the PjBL e-logbook, while FC has a positive but non-significant effect on BI; in turn, BI and FC significantly predict The PjBL e-logbook use behavior. PE emerged as the strongest predictor of BI, indicating that students' perceptions of the usefulness of the PjBL e-logbook are crucial for building intention. When biology education students perceive that the e-logbook helps them work more efficiently, improve the quality and creativity of their work, and reduce workload, they are more motivated to adopt and recommend it, a pattern that aligns with previous UTAUT-based research in mobile and blended learning (Almaiah et al., 2019; Li et al., 2022) and with acceptance studies of AI tools in education (Habibi et al., 2024). EE also had a significant effect on BI, suggesting that ease of learning and using the PjBL e-logbook contributes to acceptance; a friendly interface, simple steps, and minimal training needs reduce perceived effort and encourage use, especially during early implementation at Universitas Jambi.

Although SI had a smaller coefficient, it still significantly influenced BI, reflecting the role of classmates' and lecturers' expectations in shaping students' intentions, consistent with findings from Wijaya et al. (2022) and Al-Adwan et al. (2022) on social and institutional influences in technology acceptance. FC did not significantly affect BI but did have a significant direct effect on UB, in line with UTAUT's assumption that FC supports actual behavior more than intention (Venkatesh et al., 2003); adequate hardware, software, internet access, and training resources allow students to use the PjBL e-logbook regularly, even if these factors do not directly shape their intentions, echoing concerns from other contexts where insufficient institutional support hinders technology adoption (Chimbunde & Jakachira, 2025; Kaeane & Molokomme, 2025). BI strongly predicted PjBL e-logbook use behavior, confirming its role as a proximal determinant of actual use, and together BI and FC explained a meaningful portion of the variance in UB, indicating that both motivational and infrastructural factors are important for sustained e-logbook use.

The findings are also consistent with literature emphasizing lecturer support in technology-enhanced learning: lecturers who provide clear expectations, relational support, and feedback can strengthen students' motivation, trust, and engagement (O'Keeffe et al., 2023; Suryadi et al., 2024; Sari et al., 2023), and in this context, lecturers who consistently integrate the PjBL e-logbook into course activities and assessment likely shape students' SI and perceptions of PE and EE, while institutional efforts to improve digital infrastructure and training enhance FC and thus support actual e-logbook use. Theoretically, this study confirms the applicability of UTAUT in explaining acceptance of a PjBL e-logbook among biology education students at Universitas Jambi. It builds on previous work on the acceptance of technology and AI in Indonesian higher education (Habibi et al., 2024).

Practically, the results suggest that program leaders and lecturers should explicitly demonstrate how the PjBL e-logbook enhances project organization, learning quality, and creativity (PE), ensure that the e-logbook is easy to use with clear instructions, user-friendly interfaces, and minimal technical barriers (EE), leverage social and lecturer support by establishing norms for regular use, modeling good practice, and providing constructive feedback (SI), and strengthen facilitating conditions by improving access to devices, internet, and training opportunities (FC).

This study has several limitations: it was conducted in a single study program at one university, which may limit the generalizability of the findings, and its cross-sectional design restricts conclusions about changes in acceptance over time; future research could examine longitudinal trajectories of e-logbook use, explore moderating effects such as gender, digital literacy, and prior PjBL experience, and link e-logbook use to measurable learning outcomes and teaching competencies.

CONCLUSION

This study examined biology education students' acceptance and use of a PjBL e-logbook at Universitas Jambi using the UTAUT model. The findings show that performance expectancy, effort expectancy, and social influence are significant determinants of behavioral intention to use the PjBL e-logbook, while facilitating conditions primarily influence actual use. Behavioral intention is the strongest predictor of PjBL e-logbook use, with a smaller but significant effect of facilitating conditions. These results highlight the importance of designing PjBL e-logbooks that are clearly beneficial and easy to use, accompanied by strong lecturer and peer support and adequate infrastructural conditions. For Biology Education Study Program at Universitas Jambi, strengthening these dimensions can promote more consistent and meaningful use of the PjBL e-logbook, ultimately supporting deeper project-based learning and better preparation for future biology teachers.

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