

# Bridging Pedagogy and Technology: Project-Based Learning for Digital Competence in EFL Microteaching

Yuvita Yuvita

English Education Department, Universitas Negeri Semarang, Semarang, Indonesia

Rudi Hartono

English Education Department, Universitas Negeri Semarang, Semarang, Indonesia

Sri Wuli Fitriati

English Education Department, Universitas Negeri Semarang, Semarang, Indonesia

Mursid Saleh

English Education Department, Universitas Negeri Semarang, Semarang, Indonesia

**Abstract**—This study examines the effectiveness of Project-Based Learning (PBL) in developing digital competencies among pre-service English as a Foreign Language (EFL) teachers in Indonesia. It specifically explores the learning experiences of 30 pre-service teachers as they engaged in PBL-based microteaching activities aimed at enhancing their digital competence. Adopting an explanatory sequential mixed methods design, the study employed pre- and post-intervention digital competence surveys and mixed video creation tasks to assess progress. The findings indicate significant improvement across five domains of digital competence: information literacy, communication, digital content creation, safety, and problem-solving. Participants demonstrated notable increases in mean scores across these domains, underscoring the efficacy of PBL in cultivating essential digital skills. Qualitative data from participant interviews further revealed that, despite challenges such as technical difficulties and time constraints, the pre-service teachers actively employed collaborative and strategic approaches to overcome these obstacles. Moreover, they developed and applied innovative practices to strengthen their digital competencies, reflecting a strong commitment to technology integration in their prospective teaching careers. The study underscores the importance of embedding PBL within teacher education curricula to better prepare future educators for the pedagogical demands of an increasingly digitalized learning environment.

**Index Terms**—project-based learning, digital competency, microteaching, pre-service EFL teachers

## I. INTRODUCTION

The rapid advancement of digital technology has fundamentally reshaped the landscape of education, particularly in how teachers plan, deliver, and assess instruction. In the 21st century, digital competence is no longer a peripheral skill but a core component of effective teaching (Admiraal et al., 2017; Beach et al., 2020). As defined by the European Commission's Digital Competence Framework (DigCompEdu), digital competence encompasses a wide range of abilities, including information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Falloon, 2020; Ferrari & Redecker, 2012). For English as a Foreign Language (EFL) teachers, these competencies are essential to facilitating engaging, inclusive, and differentiated learning experiences. Digital tools allow EFL teachers to create interactive tasks, access authentic materials, promote learner autonomy, and bridge linguistic and cultural gaps through global connectivity (Nguyen & Nguyen, 2021). In this context, the demand for digitally competent EFL educators continues to grow, placing significant responsibility on teacher education institutions to integrate digital skill development into pre-service teacher training.

Despite this growing imperative, research suggests that many pre-service teachers graduate without the digital competencies required to integrate technology meaningfully into their future classrooms (Mishra & Koehler, 2006; Nuraini et al., 2025). While often familiar with everyday digital applications, pre-service teachers frequently lack pedagogical digital competence—defined as the ability to use digital tools to enhance instructional effectiveness and student learning (Schmid et al., 2020; Tohara et al., 2021). Inadequate exposure to practical and pedagogical uses of digital technology during teacher preparation often leads to superficial integration, where digital tools are used merely for presentation or administrative purposes rather than to transform teaching and learning. Moreover, many teacher education programs focus heavily on theoretical coursework and traditional microteaching sessions, which may not reflect the realities and complexities of technology-rich classroom environments (Yazon, 2019). This disconnects

between preparation and practice underscores the urgent need for instructional innovations that provide authentic, hands-on digital learning experiences for teacher candidates.

Project-Based Learning (PBL) offers a pedagogical alternative that has the potential to address this gap. Rooted in constructivist and experiential learning theories, PBL promotes active, student-centered learning through the completion of extended, interdisciplinary projects that address real-world problems (Tsybulsky et al., 2020). Unlike traditional instruction, PBL requires learners to engage in inquiry, problem-solving, collaboration, and critical reflection—often through the integration of digital tools and platforms (Taylor & Patel, 2019). When applied in teacher education, PBL allows pre-service teachers to simulate the teaching process by designing and implementing projects that incorporate technology in meaningful ways. Through this approach, digital competence is not taught as an isolated skill set but developed organically as part of a broader process of instructional design, content creation, and peer collaboration (Garib, 2023).

Several studies have highlighted the potential of PBL to improve both pedagogical and digital competencies among pre-service teachers. For instance, Baysura (2016) reported that PBL promotes self-directed learning, creativity, and collaborative problem-solving, which are critical components of digital competence. Greenier (2020) also found that project-based environments help teacher candidates to internalize and apply digital tools more confidently when those tools are embedded within authentic tasks. Moreover, PBL supports the development of Technological Pedagogical Content Knowledge (TPACK), an integrated framework that emphasizes the interplay between technology, pedagogy, and subject matter expertise (Martinez & Rodriguez, 2019). However, while these benefits have been documented in STEM and general education programs, there remains a scarcity of research examining the implementation and outcomes of PBL in EFL-specific contexts, where the nature of teaching and learning requires specialized approaches to language and communication.

In Indonesia, the integration of digital learning in schools has become a national priority, especially under the policies introduced through the *Merdeka Belajar* (Freedom to Learn) curriculum reform. These reforms emphasize student-centered learning, digital literacy, and teacher innovation as cornerstones of a modern education system. Yet, teacher education programs across the country still face significant challenges in aligning their practices with these ideals. Many pre-service English teachers continue to receive training that is dominated by lecture-based instruction and simulated teaching practices with limited or superficial use of technology (Siswanto et al., 2022). Microteaching—a key component of pre-service training designed to allow candidates to practice instructional delivery in a controlled environment—has often failed to incorporate meaningful digital integration. This shortcoming not only limits the relevance of microteaching to real-world classrooms but also hinders the digital development of future EFL educators.

Although the benefits of PBL in teacher education have been acknowledged, few empirical studies have explored how it can be integrated into microteaching to enhance digital competence among pre-service EFL teachers in Indonesia. Most existing research either focuses broadly on digital literacy or evaluates the effectiveness of technology integration from a policy or infrastructure standpoint (Moiseienko et al., 2024; Nguyen & Pham, 2024). Moreover, the majority of studies on PBL tend to adopt either a purely quantitative or qualitative approach, limiting a holistic understanding of its outcomes. There is a need for research that combines both measurable indicators of digital competence with rich, descriptive accounts of the learning process (Okogbue, 2019). Such research would not only assess the impact of PBL on skill acquisition but also capture the challenges, strategies, and transformations experienced by pre-service teachers throughout their learning journey.

To address these gaps, this study investigates the implementation of PBL within microteaching and its role in developing the digital competencies of pre-service EFL teachers in Indonesia. Through an explanatory sequential mixed methods design, the research evaluates digital competence development across five key domains—information, communication, content creation, safety, and problem-solving—while also exploring the personal learning experiences of the participants. By integrating survey data, performance-based video tasks, and in-depth interviews, the study offers a comprehensive account of how PBL contributes to both technical skill development and professional growth in a teacher training context.

By focusing on the Indonesian EFL context, the study contributes new insights into how pedagogical innovation can support teacher preparation in emerging educational systems. The findings are expected to inform teacher education policies and practices by highlighting the value of embedding PBL into microteaching to foster digital competencies. Ultimately, the study advocates for a more integrative and experiential approach to teacher education that equips future educators with the skills, mindsets, and confidence needed to thrive in technology-rich classrooms. To guide this investigation, the study poses the following research questions: (1) How effective is PBL in developing the English pre-service teachers' digital competencies in the microteaching? and (2) How do English pre-service teachers experience their learning journey in PBL for digital competencies during the microteaching?

## II. RESEARCH METHOD

This study adopted an explanatory sequential mixed methods design, which involves the collection and analysis of quantitative data in the first phase, followed by qualitative data in the second phase to elaborate, interpret, and contextualize the initial findings (Creswell & Plano Clark, 2011). This design was chosen to provide both the breadth and depth of understanding needed to examine how Project-Based Learning (PBL) fosters the digital competencies of

pre-service English as a Foreign Language (EFL) teachers. The sequential integration of quantitative and qualitative methods enabled the researchers to assess measurable changes in participants' digital competencies and to gain nuanced insights into their learning experiences throughout the PBL intervention.

In the quantitative phase, data were collected through a series of structured progress tests and a digital competence questionnaire. The purpose of this phase was to establish baseline digital skill levels, track changes over time, and identify patterns in the development of digital competence among the participants. Four performance-based assessments were administered at different stages of the intervention: a pre-test, two progress tests, and a post-test. These tests required participants to create instructional videos using digital tools, and the resulting artifacts were evaluated using an analytic rubric adapted from existing models of digital content creation (Christine, 2017; Ferrari & Redecker, 2012; Outeda, 2024). Additionally, a 50-item questionnaire based on the European Digital Competence Framework (DigComp) was administered both before and after the intervention. The instrument measured participants' perceived competence across five domains: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem-Solving. Each item was rated on a five-point Likert scale, and the instrument demonstrated high reliability and validity in previous studies (Miles et al., 2014).

The qualitative phase followed the analysis of the quantitative data and was designed to provide deeper insights into the participants' lived experiences during the PBL intervention. Five participants were purposively selected based on their questionnaire responses to represent a range of digital competence levels and learning trajectories. Semi-structured interviews were conducted to explore the challenges, strategies, and reflective insights participants encountered as they engaged in project-based microteaching. Each interview lasted between 15 and 35 minutes and was conducted either offline or online, depending on participant availability. The interviews were audio-recorded, transcribed, and analyzed thematically following Braun and Clarke's (2017) six-phase approach to thematic analysis, which includes familiarization with data, generating initial codes, searching for themes, reviewing themes, defining themes, and producing the report. This approach allowed for the identification of recurring patterns and critical incidents that illuminated the developmental process of digital competence in a project-based learning environment.

To ensure a comprehensive and meaningful interpretation, the integration of quantitative and qualitative data employed a "weaving" technique (Cohen et al., 2002), wherein findings from both phases were presented together within the discussion of each theme. This approach allowed the study to triangulate numerical trends with participants' narratives, explaining both typical outcomes and anomalies. For example, instances where quantitative scores did not significantly improve were cross-examined with qualitative data to uncover contextual factors such as technical difficulties or varying levels of prior experience. Through this integrative analysis, the study aimed to generate a holistic understanding of how PBL influences digital competence development.

The participants of this study consisted of 30 pre-service English teachers (10 males and 20 females) enrolled in their seventh semester at Universitas Pancasakti Tegal, Indonesia. All participants were drawn from a teacher education program that included both coursework and field experience components, ensuring their readiness to engage in practice-based interventions. The use of purposive sampling for qualitative interviews enabled the researchers to explore diverse experiences and to gain insight into the broader findings revealed in the quantitative phase.

To ensure the credibility and trustworthiness of the research, data triangulation was employed by using three distinct data sources: (1) video creation tests evaluated with a standardized rubric, (2) digital competence questionnaires administered pre- and post-intervention, and (3) semi-structured interviews. This methodological triangulation helped to enhance the validity of the findings and provided multiple perspectives on the same phenomenon (Bans-Akutey & Tiimub, 2021). In addition, steps were taken to reduce potential researcher bias through collaborative coding and peer debriefing during the qualitative analysis.

Quantitative data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics—including mean, median, and standard deviation—were used to summarize participants' competence levels across the five digital domains. Paired-sample t-tests and analysis of variance (ANOVA) were applied to determine statistically significant differences between pre- and post-intervention scores. These inferential analyses enabled the researchers to draw conclusions about the effectiveness of the PBL intervention in enhancing digital competencies over time.

Finally, ethical considerations were carefully observed throughout the study. Informed consent was obtained from all participants prior to their involvement in both the quantitative and qualitative phases. Anonymity and confidentiality were maintained through the use of pseudonyms, and all data were securely stored in compliance with institutional ethical guidelines (Hasal et al., 2021; Merriam, 1998). The study was approved by the ethics committee of the affiliated university, ensuring that all procedures met the required standards for research involving human subjects.

### III. FINDINGS

#### A. *The Effectiveness of PBL in Developing Pre-Service EFL Teachers' Digital Competencies in the Microteaching*

This section presents the findings related to the first research question: How effective is Project-Based Learning (PBL) in developing the digital competencies of pre-service EFL teachers during microteaching? The analysis is divided into two main components: (1) the results of video creation performance tests, and (2) the outcomes of the Digital Competence Survey administered before and after the PBL intervention. Together, these components offer

quantitative evidence of growth in digital competencies and provide a reliable measure of PBL's effectiveness as an instructional strategy.

Prior to analyzing the results, a series of statistical procedures were conducted to ensure the validity and reliability of the data. First, normality tests were performed using the Shapiro-Wilk test, which is recommended for small sample sizes (Khatun, 2021). The results indicated that the pre- and post-test scores were normally distributed, as all significance values were greater than 0.05 ( $p > 0.05$ ). In addition, multivariate normality was assessed by examining skewness and kurtosis, with the Critical Ratio (c.r) values for both falling within the acceptable range of -2 to +2, confirming the assumption of multivariate normality (Kline, 2015).

To further validate the dataset, Mahalanobis distance was used to detect potential outliers. This statistical method measures the distance of each data point from the centroid of a multivariate distribution. The analysis revealed no multivariate outliers, with the maximum Mahalanobis d-squared value in the second survey being 12.71524, which is below the critical threshold ( $p > 0.001$ ;  $d^2 = 22.45774$ ). These findings confirm that the dataset is statistically sound and suitable for further inferential analysis.

To evaluate the development of participants' practical digital skills, four video creation tests were administered throughout the intervention: a pre-test, two progress tests, and a post-test. These assessments were designed to gauge the participants' ability to integrate digital tools into teaching materials—specifically through the design and production of microteaching videos. Each task required students to plan, record, and edit a lesson using educational technology tools such as video editors, screen recorders, and interactive media platforms. The evaluation of the videos followed a standardized rubric based on the DigComp 2.1 framework (Christine, 2017; Ferrari & Redecker, 2012; Outeda, 2024), assessing key dimensions such as content relevance, technical execution, creativity, and pedagogical value. The results, summarized in Table 1, demonstrated consistent improvement across all four testing points. Notably, there was a significant increase in the average scores from the pre-test to the post-test, indicating substantial progress in the application of digital tools for instructional purposes.

Table 1 illustrates a clear upward trend in participants' performance across the four video creation assessments, providing strong evidence of progressive skill development over the course of the PBL intervention. The average score in the pre-test was 59.52, indicating a relatively low initial level of digital competence in designing and producing instructional videos. This baseline suggests that prior to the intervention, many pre-service teachers lacked familiarity with digital tools and pedagogical strategies for multimedia content creation.

TABLE 1  
SUMMARY OF TEST RESULTS

Test	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Test	30	51.00	68.00	59.52	3.61
Progress Test 1	30	75.00	90.00	84.03	4.42
Progress Test 2	30	75.00	96.00	88.00	4.65
Post Test	30	77.75	94.25	87.05	3.61

Following the introduction of PBL activities, there was a marked improvement in Progress Test 1, with the mean score increasing significantly to 84.03. This jump reflects the participants' initial gains in understanding and applying digital tools for educational purposes, supported by hands-on project work and peer collaboration. By Progress Test 2, the mean score rose further to 88.00, signaling continued enhancement of technical proficiency, creativity, and pedagogical integration in their video productions. This steady improvement suggests that sustained engagement with iterative projects and scaffolded feedback contributed positively to their digital competence development.

Interestingly, the Post-Test scores showed a slight decline to 87.05, though still notably higher than earlier results. This minor decrease may be attributed to external factors such as time constraints during the final week of the intervention, which potentially limited the participants' preparation and editing time. Nevertheless, the overall pattern remains positive, and the slight dip does not detract from the substantial progress demonstrated throughout the PBL process. In line with previous studies (Nukholida et al., 2023; Ambros et al., 2023; Lapina & Prakasha, 2022), the findings affirm that well-structured PBL tasks can significantly enhance learners' digital competencies by fostering authentic, task-based learning experiences. These results confirm that PBL, when systematically implemented in a microteaching context, effectively supports the development of essential digital competencies among pre-service EFL teachers. The next section presents the findings from the Digital Competence Survey to further substantiate these conclusions with self-reported data.

To further explore the effectiveness of Project-Based Learning (PBL) in enhancing pre-service EFL teachers' digital competencies, a Digital Competence Survey was administered both before and after the intervention. This instrument, adapted from the European Digital Competence Framework (Ferrari & Redecker, 2012; Outeda, 2024), assessed five key domains: Information, Communication, Content Creation, Safety, and Problem-Solving. The survey results revealed statistically significant improvements across all domains, suggesting that the PBL approach contributed meaningfully to the participants' development of digital literacy skills required in 21st-century teaching environments.

TABLE 2  
SUMMARY OF INFORMATION CHANGES FROM BEFORE AND AFTER PBL

No	Question	Mean Information	Change
1	I recognize my high proficiency level to browse the material online	2.61	2.06
2	I am able to use and search the specific keywords	3.15	1.64
3	I am able to filter trusted information/material	3.67	1.03
4	I am able to search in Multiple search engines and links	2.94	1.21
5	I recognize the originality of the website	3.30	0.18
6	I am able to organize the information on websites	3.03	1.06
7	I usually save the file organized based on the name	2.76	0.15
8	I am able to use cloud backup in my files	2.94	0.67
9	I recognize the shortcut to search material accurately	3.21	0.85
10	I am able to store scientific papers in a reference manager	2.97	1.76

In the domain of Information Competence, as shown in Table 2, participants demonstrated improved ability to identify, locate, retrieve, store, and evaluate digital information effectively. The most notable improvement (mean difference = 2.06) was in participants' self-reported proficiency in browsing and retrieving relevant learning materials from online sources. This suggests that throughout the project-based tasks, pre-service teachers became more adept at navigating digital platforms for educational content. However, the lowest gain (0.15) was recorded in the sub-skill of using consistent and logical file naming conventions, indicating that while participants improved in information search strategies, attention to detail in organizing digital files remained a relatively weaker area.

TABLE 3  
SUMMARY OF COMMUNICATION CHANGES

No	Question	Mean Before	Mean After	Change
1	I am able to lead my team to brainstorm ideas	3.24	5.12	1.88
2	I am able to deliver my ideas to my team	2.88	5.18	2.30
3	I am able to support the ideas from my team	3.48	5.27	1.79
4	I am able to serve and deliver the project	3.12	5.21	2.09
5	I can coordinate the presentation (Google Slides)	2.76	5.03	2.27
6	I usually review the project with my team	2.88	5.12	2.24
7	I can receive critique	2.91	5.09	2.18

Regarding Communication Competence, Table 3 illustrates substantial growth in participants' digital collaboration and communication skills. The mean score for the ability to brainstorm with peers increased by 1.88 points, while the capacity to articulate and deliver ideas within a team context rose even more sharply, by 2.30 points. These findings reflect the inherently collaborative nature of PBL activities, which required pre-service teachers to engage in regular discussion, negotiation, and decision-making through digital communication tools. Such improvement aligns with previous studies asserting that PBL encourages meaningful peer interaction and strengthens digital interpersonal skills (Prasetyo et al., 2023; Gómez-Pablos et al., 2017).

TABLE 4  
SUMMARY OF CONTENT CREATION CHANGES

No	Question	Mean Before	Mean After	Change
1	I am able to create a script for a video	2.91	4.76	1.85
2	I am able to create a learning video	2.79	4.85	2.06
3	I am able to record the learning video	3.27	4.58	1.30
4	I can operate various digital equipment in the classroom	2.85	4.94	2.09
5	I can create and design content for my website	2.79	5.18	2.39
6	I can fix technical issues in digital creation	3.24	5.00	1.76
7	I bring various new applications and online platforms	3.12	4.79	1.67
8	I understand the value of originality in my project	3.24	4.73	1.48
9	I can avoid plagiarism in my project	3.42	4.82	1.39
10	I can choose appropriate teaching materials	2.85	4.82	1.97
11	I can choose appropriate teaching media	3.03	4.91	1.88

In the area of Content Creation, the data in Table 4 demonstrate that participants significantly enhanced their ability to produce educational content using digital tools. The ability to write teaching scripts improved by 1.85 points, while the competence in producing learning videos saw a notable increase of 2.06 points. These gains suggest that PBL encouraged authentic and practical content development, fostering creative expression through the integration of pedagogical and technological knowledge. Moreover, the participants also showed increased awareness and application of ethical digital practices. Notably, improvements were recorded in avoiding plagiarism and in selecting appropriate and relevant teaching materials, suggesting a maturing understanding of digital authorship, content accuracy, and instructional design.

TABLE 5  
SUMMARY OF CONTENT CREATION CHANGES

No	Question	Mean Before	Mean After	Change
1	I avoid clicking unknown links	2.58	5.15	2.58
2	I use protection software to surf the internet	3.18	5.18	2.00
3	I can search and store passwords	2.91	4.73	1.82
4	I usually use the same password across platforms	2.79	4.79	2.00
5	I know what information I should not share	3.27	4.61	1.33
6	I understand how my data will be used	3.24	4.27	1.03
7	I know the policy for using content properly	2.79	4.58	1.79
8	I can encrypt/lock team data to avoid cheating	3.00	4.88	1.88
9	I can detect if a computer has a virus	2.73	3.94	1.21

Safety Competence (as reflected in Table 5) also demonstrated improvement, particularly in data protection and digital identity management. This indicates that PBL may have contributed to raising awareness about responsible and secure engagement with digital tools as an essential aspect of digital literacy in educational settings.

TABLE 6  
SUMMARY OF PROBLEM-SOLVING CHANGES

No	Question	Mean Before	Mean After	Change
1	I can compose a solution for project problems	2.91	5.18	2.27
2	I can plan small activities in my project	2.55	5.15	2.61
3	I can identify the root problems in project-based learning	2.91	5.48	2.58
4	I can plan to improve teaching quality	3.18	5.30	2.12
5	I learn new software by practicing	2.88	5.61	2.73
6	I can revise the teaching process as needed	3.18	5.45	2.27
7	I help my team find effective ways to reach project goals	2.91	5.42	2.52
8	I can manage conflicts within the team	3.03	5.27	2.24
9	I can tolerate differences within my team	3.03	5.15	2.12

Finally, the domain of Problem-Solving Competence, as outlined in Table 6, showed some of the most substantial gains. Participants reported notable improvements in planning project activities (mean gain = 2.61) and in their ability to revise or adapt teaching processes based on feedback and reflection (mean gain = 2.27). These findings underscore the effectiveness of PBL in cultivating critical thinking and adaptive skills, as pre-service teachers were continually engaged in identifying challenges, reflecting on their digital teaching practices, and making strategic revisions throughout the microteaching projects. This is consistent with prior research emphasizing the value of PBL in promoting self-regulated learning and flexible problem-solving (Iordache, 2017; Lee & Kim, 2020).

Overall, the Digital Competence Survey results confirm that PBL significantly improved pre-service EFL teachers' digital skills across multiple areas. The gains were not only quantitative but also reflected the development of a more reflective, ethical, and collaborative approach to digital tool use in teaching. These outcomes suggest that integrating PBL into teacher education programs can serve as a strategic approach to fostering digital competencies aligned with modern pedagogical demands.

#### B. Pre-Service EFL Teachers' Learning Experience in PBL for the Digital Competencies During the Microteaching

In addressing the second research question, this section explores the lived experiences of English pre-service teachers in engaging with Project-Based Learning (PBL) and how it shaped their digital competencies. The insights were drawn from post-intervention interviews, and the data illuminated three interrelated themes: the challenges encountered during the implementation of PBL, the strategies developed to address those challenges, and the reflections on their growth across various domains of digital competence.

Participants commonly reported several obstacles that affected their participation and performance during the PBL process. One of the most pressing issues was technological limitation, particularly unstable internet connections and insufficient data quotas, which disrupted both access to learning materials and communication within teams.

Respondent 1 emphasized, “The main problem is about the connection, signal, or the run out of quota,” illustrating how infrastructure issues posed a constant threat to participation in digital-based projects. Similarly, Respondent 4 shared, “Sometimes I have already prepared my video, but it took very long to upload because the signal was not good,” pointing to delays in task submission and frustration with unreliable digital environments. These technological barriers were further compounded by gaps in digital literacy and access to proper devices. For instance, Respondent 3 reflected, “The problem of ICT tools in the learning process is the lack of knowledge, lack of devices, and sometimes not having enough signals to access platforms.” This lack of access not only challenged their technical engagement but also influenced their confidence in navigating digital platforms efficiently.

Despite these limitations, many pre-service teachers demonstrated resilience and adaptability through various self-initiated strategies to enhance their digital engagement. One of the key approaches was ensuring reliable internet access before engaging in collaborative work. As Respondent 2 put it, “I will make sure the connection is stable, signal, and I will make sure either me or students have enough quota,” reflecting a heightened awareness of digital readiness as a prerequisite for participation. In addition to technical preparedness, peer collaboration emerged as a valuable strategy for overcoming skill gaps. Respondent 5 noted, “When one of us didn’t know how to edit the video, others helped by making tutorials or sharing screen during a Zoom meeting.” This peer-driven support system cultivated a collaborative learning atmosphere where students not only built digital competencies but also developed a culture of mutual assistance. Furthermore, time management and structured planning played a vital role in reducing stress and promoting accountability. Respondent 6 remarked, “I learned to set a clear timeline for each step—writing script, recording, editing—so the work didn’t pile up near the deadline.” This practical adjustment shows how students developed essential project management skills that are transferable beyond the PBL context.

As students reflected on their experiences, they articulated growth across all five domains of digital competence—information, communication, content creation, safety, and problem-solving. Their reflections revealed not just improved technical skills, but also a more strategic and critical engagement with digital technologies. Respondent 1, for example, shared, “Before, I just searched anything on Google. But now, I know how to choose trusted websites and save files properly,” indicating an increased awareness of information reliability and digital organization. In the area of communication, students reported increased proficiency in digital collaboration, as Respondent 3 stated, “Now I can coordinate in group projects better through Google Meet, Telegram, and Google Docs. We divide the work and check progress more easily.” Such experiences demonstrate how PBL fostered not only the use of digital platforms but also the interpersonal skills required for effective teamwork in virtual environments.

Content creation skills also showed marked improvement, particularly in the design and production of teaching materials. Respondent 4 expressed, “Creating the teaching video was hard at first, but now I can write the script, record, and edit it using CapCut or Canva with less help,” revealing a transition from dependency to independent digital production. This hands-on experience not only increased their familiarity with various tools but also built confidence in producing creative, educational content. Students also reported growing awareness of ethical digital practices. As highlighted by Respondent 6, “Now I always make sure not to copy content directly and to choose materials that are suitable for my lesson objectives,” demonstrating a stronger understanding of content integrity and pedagogical alignment.

Lastly, the ability to respond to challenges with thoughtful adaptations was a recurring reflection across interviews. Respondent 2 explained, “We had to revise our video plan because the school context was different. So we changed the examples and visuals to fit junior high school students,” showcasing their capacity to make pedagogically informed decisions while solving real-time problems. This ability to adjust and revise digital content based on context highlights their development in both problem-solving and instructional design—skills that are critical for future teaching practices.

Overall, these findings underscore that while the PBL experience presented significant hurdles, it also served as a powerful platform for English pre-service teachers to cultivate their digital competencies. Through hands-on tasks, peer collaboration, and reflective practices, participants not only gained technical knowledge but also built the mindset and strategies necessary for navigating digital teaching environments effectively.

#### IV. DISCUSSION

This study aimed to investigate the effectiveness of PBL in developing the digital competencies of pre-service EFL teachers and to explore their lived experiences with the challenges and strategies for overcoming digital barriers during their microteaching. The findings contribute to the growing body of literature on integrating digital competencies in teacher education, particularly in the context of under-resourced educational environments.

The first research question explored the effectiveness of PBL in developing pre-service teachers' digital competencies, particularly in the context of microteaching. The results demonstrated significant improvements in participants' digital skills across various assessments. These improvements were particularly notable in areas such as content creation and problem-solving, which were central to the PBL tasks. The findings align with the growing body of literature that supports PBL as an effective pedagogical approach for fostering 21st-century skills, including digital literacy (Moiseienko et al., 2024; Potyrała & Tomczyk, 2021). By engaging in authentic, hands-on projects, pre-service teachers were able to develop the technical and cognitive skills necessary to use digital tools effectively in the classroom.

The increase in digital competency, as reflected in both the video creation tests and digital competence surveys, suggests that PBL provides a meaningful context for learning. It enables pre-service teachers to engage with technologies that are relevant to their future teaching practices. The marked improvement in areas such as script creation, video production, and digital content curation underscores the potential of PBL to promote creativity and innovation among pre-service teachers (García, 2017). These findings corroborate those of previous studies, which have shown that PBL fosters deeper engagement and skill development by requiring students to apply their learning to real-world tasks (Taylor & Patel, 2019; Siswanto et al., 2022). Additionally, the improvements in problem-solving abilities reflect the development of critical thinking skills that are essential for teachers to navigate the complexities of modern classrooms.

However, while the results were generally positive, the slight decline in post-test scores suggests that certain challenges, such as time constraints, may have hindered the participants' ability to fully demonstrate their competencies in the final stages of the project. This observation highlights the need for adequate preparation time and scaffolding to ensure that students are able to perform optimally in digital tasks. It also points to the importance of balancing the complexity of PBL tasks with the available resources and support structures (Nguyen & Nguyen, 2021).

The second research question focused on the experiences of pre-service teachers during PBL and how these experiences shaped their digital competencies. The study revealed that participants faced several significant challenges, particularly related to technical issues and limited access to ICT tools. Connectivity problems, such as unstable internet signals and data limitations, were identified as the most persistent barriers to effective learning. This is consistent with existing research on the digital divide, which emphasizes how unequal access to digital resources can affect educational outcomes (Nguyen & Pham, 2024; García, 2017). Connectivity issues were particularly challenging in the context of PBL, where continuous engagement with digital platforms and collaborative tools is essential.

In addition to connectivity problems, participants also faced difficulties with the technical aspects of digital tools, as well as the lack of familiarity with certain software and platforms. This finding reinforces the notion that digital competence extends beyond the ability to use digital tools and includes a deep understanding of how to integrate these tools effectively into teaching practices (Garib, 2023). The study highlights the need for teacher education programs to provide pre-service teachers with opportunities to not only familiarize themselves with a range of digital tools but also to develop the critical thinking and problem-solving skills necessary for addressing challenges in real-time.

Despite these obstacles, participants demonstrated resilience and a proactive approach to overcoming challenges. Many students reported that they took steps to ensure stable internet connections and sufficient data quotas, reflecting a growing sense of agency in managing the technical aspects of PBL. This proactive mindset is a crucial component of digital competence, as it empowers teachers to troubleshoot and adapt to changing technological environments (Admiraal et al., 2017). Moreover, the use of peer collaboration as a strategy for problem-solving underscores the value of social learning in PBL contexts. By working together to address issues, pre-service teachers not only strengthened their own skills but also developed collaborative communication skills, which are essential for success in digital learning environments (Falloon, 2020).

These findings suggest that PBL, while presenting certain challenges, also offers valuable opportunities for pre-service teachers to develop the skills and strategies necessary for navigating the complexities of digital education. The ability to adapt to technological challenges, seek solutions independently, and collaborate with peers is indicative of a higher level of digital competence, which is essential for teachers in the 21st century.

## V. CONCLUSION AND SUGGESTION

This study concludes that Project-Based Learning (PBL) is a highly effective pedagogical strategy for enhancing the digital competencies of pre-service English language teachers. The findings revealed significant improvements in the participants' abilities to create educational content, communicate effectively, and solve problems using digital tools. Specifically, the results from the video creation tests showed measurable increases in participants' proficiency with various digital platforms, such as video editing and online collaboration tools. Furthermore, the Digital Competence survey demonstrated that the participants made notable progress in key domains, including Information, Communication, Content Creation, Safety, and Problem-Solving. The data suggests that the hands-on, real-world nature of PBL provides pre-service teachers with opportunities to apply digital skills in authentic teaching scenarios, thus preparing them to integrate technology into their future classrooms more effectively. These findings align with prior research, which emphasizes the importance of incorporating technology into teacher education programs to develop the necessary competencies for the digital age (Meyers et al., 2013; Greenier, 2020).

Moreover, the study highlighted the challenges that participants faced during the PBL intervention, particularly related to technical issues such as unstable internet connections, limited data access, and inadequate familiarity with certain digital tools. These challenges were particularly pronounced in environments where connectivity was unreliable, and the lack of access to devices or platforms hindered smooth engagement with the learning process. However, participants demonstrated resilience in overcoming these barriers, employing strategies such as ensuring stable internet connections, securing sufficient data, and gradually familiarizing themselves with new technologies. These proactive strategies not only helped participants overcome immediate obstacles but also reflected a deeper commitment to their professional growth and a growing understanding of the importance of digital competency in teaching. This finding

highlights the importance of identifying technical challenges as a significant barrier to the effective use of ICT in education. However, it also underscores the potential for developing solutions through targeted interventions and resource allocation.

In light of the study's findings, several implications for teacher education programs emerge. First, it is essential for such programs to integrate PBL more systematically into their curriculum, as it provides pre-service teachers with a platform to develop critical digital competencies while engaging in authentic teaching practices. However, to fully maximize the benefits of PBL, teacher education programs must address infrastructure limitations, such as unreliable internet access and the availability of devices. Programs should also offer specific training on the use of digital tools and resources, ensuring that all students, regardless of their prior exposure to technology, have the skills required for effective participation. Additionally, future research could expand on the current study by exploring the long-term effects of PBL on digital competencies, examining how these skills translate into real-world classroom teaching. Further research should also investigate how PBL can be adapted for different teaching contexts, including various subjects and educational levels, to determine its broader applicability in enhancing digital literacy across the education sector.

#### REFERENCES

- [1] Admiraal, W., van Vugt, F., Kranenburg, F., Koster, B., Smit, B., Weijers, S., & Lockhorst, D. (2017). Preparing pre-service teachers to integrate technology into K–12 instruction: evaluation of a technology-infused approach. *Technology, Pedagogy and Education*, 26(1), 105–120. <https://doi.org/10.1080/1475939X.2016.1163283>
- [2] Ambros, P., Schmid, S., & Kopp, B. (2023). Integrating Digital Competences into Teacher Education: Challenges and Opportunities. *Education Sciences*, 15(2), 160-171.
- [3] Bans-Akutey, A., & Tiimub, B. M. (2021). Triangulation in research. *Academia Letters*, 2(3392), 1-7. <https://doi.org/10.20935/AL3392>
- [4] Baysura, O. D. (2016). Perceptions of teacher candidates regarding project-based learning. *Egitim Arastirmalari - Eurasian Journal of Educational Research*, 62, 15–36. <https://doi.org/10.14689/ejer.2016.62.3>
- [5] Beach, R., Boggs, G., Castek, J., Damico, J., Panos, A., Spellman, R., & Wilson, N. (2020). Fostering Preservice and In-Service ELA Teachers' Digital Practices for Addressing Climate Change. *Contemporary Issues in Technology and Teacher Education (CITE Journal)*, 20(1), 4–36.
- [6] Clarke, V., & Braun, V. (2017). Thematic analysis. *The journal of positive psychology*, 12(3), 297-298. <https://doi.org/10.1080/17439760.2016.1262613>
- [7] Chen, I.-H., Gamble, J. H., Lee, Z.-H., & Fu, Q.-L. (2020). Formative assessment with interactive whiteboards: A one-year longitudinal study of primary students' mathematical performance. *Computers & Education*, 150, 103833. <https://doi.org/https://doi.org/10.1016/j.compedu.2020.103833>
- [8] Christine, R. (2017). *European framework for the digital competence of educators*. Joint Research Centre.
- [9] Cohen, L., Manion, L., & Morrison, K. (2002). *Research methods in education*. Routledge. <https://doi.org/10.4324/9780203224342>
- [10] Cresswell, J. W., & Plano Clark, V. L. (2011). *Designing and Conducting Mixed Methods Research (2nd Edition)*. Sage Publication.
- [11] Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational technology research and development*, 68(5), 2449-2472. <https://doi.org/10.1007/s11423-020-09767-4>
- [12] Ferrari, A., Punie, Y., & Redecker, C. (2012). Understanding digital competence in the 21st century: An analysis of current frameworks. In *21st Century Learning for 21st Century Skills: 7th European Conference of Technology Enhanced Learning, EC-TEL 2012, Saarbrücken, Germany, September 18-21, 2012. Proceedings 7* (pp. 79-92). Springer Berlin Heidelberg. [https://doi.org/10.1007/978-3-642-33263-0\\_7](https://doi.org/10.1007/978-3-642-33263-0_7)
- [13] Garib, A. (2023). "Actually, It's Real Work": EFL Teachers' Perceptions of Technology-Assisted Project-Based Language Learning in Lebanon, Libya, and Syria. *TESOL Quarterly*, 57(4), 1434-1462. <https://doi.org/10.1002/tesq.3202>
- [14] Meyers, E. M., Erickson, I., & Small, R. V. (2013). Digital literacy and informal learning environments: An introduction. *Learning, Media and Technology*, 38(4), 355–367. <https://doi.org/10.1080/17439884.2013.783597>
- [15] García, R. M. G. (2017). Educating the next generation of teachers: 21st century skills, research and ICT competencies through PBL. *Avances en Educación y Humanidades*, 31-43. <https://doi.org/10.21897/25394185.1483>
- [16] Gómez-Pablos, V. B., del Pozo, M. M., & Muñoz-Repiso, A. G. V. (2017). Project-based learning (PBL) through the incorporation of digital technologies: An evaluation based on the experience of serving teachers. *Computers in human behavior*, 68, 501-512. <https://doi.org/10.1016/j.chb.2016.11.056>
- [17] Greenier, V. T. (2020). The 10Cs of project-based learning TESOL curriculum. *Innovation in Language Learning and Teaching*, 14(1), 27–36. <https://doi.org/10.1080/17501229.2018.1473405>
- [18] Hasan, N., Rana, R. U., Chowdhury, S., Dola, A. J., & Rony, M. K. K. (2021). Ethical considerations in research. *Journal of Nursing Research, Patient Safety and Practise (JNRPS)*, 2799-1210, 1(01), 1-4. <https://doi.org/10.55529/jnrpsp.11.1.4>
- [19] Iordache, C. (2017). Developing digital skills and competences: A quick-scan analysis of 13 digital literacy models. *Italian Journal of Sociology of Education*, 9(1), 6–30. <https://doi.org/10.14658/pupj-ijse-2017-1-2>
- [20] Khatun, N. (2021). Applications of normality test in statistical analysis. *Open journal of statistics*, 11(01), 113.
- [21] Lapina, M. A., & Prakasha, G. S. (2022). Project-based learning approach to the formation of digital competencies of students of universities in Russia and India. *Informatics and Education*, 37(3), 80-87. <https://doi.org/10.32517/0234-0453-2022-37-3-80-87>
- [22] Lee, S., & Kim, H. (2020). Developing Digital Competence in Teacher Candidates through Project-Based Microteaching. *Computers & Education*, 150, 103833. <https://doi.org/10.1016/j.compedu.2020.103833>

- [23] Martinez, L., & Rodriguez, P. (2019). Integrating Project-Based Learning in Teacher Education: Effects on Digital Competence Development. *Teaching and Teacher Education*, 85, 134–145.
- [24] Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education*. Jossey-Bass Publishers.
- [25] Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook (3rd ed.)*. SAGE Publications.
- [26] Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- [27] Moiseienko, M. V., Moiseienko, N. V., & Lavrentieva, O. O. (2024). Developing pre-service teachers' digital competence through informatics disciplines in teacher education programs. *CEUR Workshop Proceedings*, 3844, 45–52.
- [28] Nguyen, H. T., & Pham, T. T. M. (2024). Factors Influencing Digital Competence of Pre-Service EFL Teachers: A Vietnamese Perspective. *Journal of Digital Learning in Teacher Education*, 40(1), 45–60.
- [29] Nguyen, T., & Nguyen, H. (2021). Project-based learning and digital literacy: Preparing pre-service teachers for the digital age. *Journal of Educational Technology & Society*, 24(1), 89–104. <https://doi.org/10.1007/s12339-021-00234-7>
- [30] Nuraini, F. I., Sodiq, J., & Prastikawati, E. F. (2025). Edmodo as Technology-Based Formative Assessment: How It Enhances Reading Comprehension. *International Journal of Research in Education*, 5(1), 81–92. <https://doi.org/10.26877/ijre.v5i1.1368>
- [31] Nurkholida, E., Sahari, A. A., & Ulfah, U. N. M. R. (2023). Upskilling Higher Education Students for Digital Competency Using Project Based Learning. *IJER (Indonesian Journal of Educational Research)*, 8(3), 72–78.
- [32] Okogbue, O. (2019). *Digital Inequality in Access and Achievement for Students: Germany's Adoption of the European Commission Digital Education Action Plan* (Master's thesis, Lehigh University).
- [33] Outeda, C. C. (2024). European Education Area and Digital Education Action Plan (2021–2027): One More Step Towards the Europeanisation of Education Policy. In *E-Governance in the European Union: Strategies, Tools, and Implementation* (pp. 187–206). Cham: Springer Nature Switzerland. [https://doi.org/10.1007/978-3-031-56045-3\\_13](https://doi.org/10.1007/978-3-031-56045-3_13)
- [34] Potyrała, K., & Tomczyk, Ł. (2021). Teachers in the lifelong learning process: examples of digital literacy. *Journal of Education for Teaching*, 47(2), 255–273. <https://doi.org/10.1080/02607476.2021.1876499>
- [35] Prasetyo, W. H., Sumardjoko, B., Muhibbin, A., Naidu, N. B. M., & Muthali'in, A. (2023). Promoting digital citizenship among student-teachers: The role of project-based learning in improving appropriate online behaviors. *Participatory Educational Research*, 10(1), 389–407. <https://doi.org/10.17275/per.23.21.10.1>
- [36] Schmid, M., Brianza, E., & Petko, D. (2020). Self-reported technological pedagogical content knowledge (TPACK) of pre-service teachers in relation to digital technology use in lesson plans. *Computers in Human Behavior*, 115. <https://doi.org/10.1016/j.chb.2020.106586>
- [37] Siswanto, J., Harjanta, A. T. J., Suminar, I., & Suyidno, S. (2022). Digital Learning Integrated with Local Wisdom to Improve Students' Physics Problem-Solving Skills and Digital Literacy. *Journal of Physics: Conference Series*, 2392(1). <https://doi.org/10.1088/1742-6596/2392/1/012025>
- [38] Taylor, R., & Patel, S. (2019). Project-based learning strategies to develop digital competence in pre-service teachers. *Journal of Research on Technology in Education*, 51(3), 274–289. <https://doi.org/10.1080/15391523.2019.1571234>
- [39] Tohara, A. J. T., Shuhidan, S. M., Bahry, F. D. S., & Nordin, M. N. bin. (2021). Exploring Digital Literacy Strategies for Students with Special Educational Needs in the Digital Age. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, 12(9), 3345–3358. <https://doi.org/10.17762/turcomat.v12i9.5741>
- [40] Tsybulsky, D., Gatenio-Kalush, M., Abu Ganem, M., & Grobgeld, E. (2020a). Experiences of preservice teachers exposed to project-based learning. *European Journal of Teacher Education*, 43(3), 368–383. <https://doi.org/10.1080/02619768.2019.1711052>
- [41] Yazon, A. D. (2019). Digital literacy, digital competence and research productivity of educators. *Universal Journal of Educational Research*, 7(8), 1734–1743. <https://doi.org/10.13189/ujer.2019.070812>

**Yuvita Yuvita** is a lecturer in English Education at the Faculty of Teacher Training and Education, Universitas Pancasakti Tegal. With a specialization in English language teaching methodology, she has made significant contributions to the field of Teaching English as a Foreign Language (TEFL) through her academic research. Her scholarly work has been published in both national and international journals, particularly focusing on areas related to TEFL. Currently, she is pursuing her doctoral dissertation, which centers on the development of digital competence within the context of English language teaching. She can be reached via email at [yuvieta@students.unnes.ac.id](mailto:yuvieta@students.unnes.ac.id)

**Rudi Hartono** is a professor at the Faculty of Languages and Arts, Universitas Negeri Semarang, Indonesia. In addition to his academic role, he is an experienced English language consultant, translator, and author of English textbooks. He teaches a range of subjects, including English–Indonesian and Indonesian–English Translation (Theory and Practice), Academic Writing, Advanced Writing, Academic English, Translating and Interpreting, and Research in Education. His primary research interests lie in translation studies and textbook development. He has authored several academic papers and books published in reputable journals and by recognized publishers, contributing significantly to the fields of translation and English language education. He can be reached via email at [rudi.hartono@mail.unnes.ac.id](mailto:rudi.hartono@mail.unnes.ac.id)

**Sri Wuli Fitriati** is a distinguished professor of English Language Education at the Faculty of Languages and Arts, Universitas Negeri Semarang, Indonesia. With a specialization in academic writing, she has contributed extensively to the scholarship of English language teaching through numerous publications focused on academic writing pedagogy, teaching and learning practices, and the integration of artificial intelligence tools in language education. She is actively involved in supervising undergraduate theses,

master's dissertations, and doctoral research, particularly in the areas of academic writing instruction and teaching methodologies. Her academic engagement also includes serving as a reviewer for several nationally accredited journals and internationally reputable academic publications, reflecting her expertise and leadership in the field. She is currently based in the Master's Program of English Language Education at Universitas Negeri Semarang and can be reached via email at [sriwuli.fitriati@mail.unnes.ac.id](mailto:sriwuli.fitriati@mail.unnes.ac.id)

**Mursid Saleh** is a senior professor in the English Education Department at Universitas Negeri Semarang, Indonesia. His academic expertise centers on Teaching English as a Foreign Language (TEFL) and research methodology. Over the course of his career, he has made substantial contributions to the field through his teaching, research, and scholarly publications. He is the author of several influential books in the area of English language education. Among his most notable works is *Six Major Traditions in Language Education Research*, which has been widely referenced in academic circles. His other publications include *Beginning Research in English Language Teaching*, *Cultural Biases in Students' Translation*, and *Pengantar Praktis Penelitian Pengajaran Bahasa*, all of which have served as key resources for both students and educators in the field. He remains actively engaged in academic mentorship, curriculum development, and scholarly writing. He can be contacted via email at [mursids@hotmail.com](mailto:mursids@hotmail.com)