Project-Based Learning for Developing Digital Skills among University Students in Vietnam

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ABSTRACT:
This study investigates the effectiveness of project-based learning in developing digital skills among university students in Vietnam. A mixed-method design was employed, involving 180 students from Thai Nguyen University of Education, the National Academy of Education Management, and Hanoi University of Industry. Over an eight-week intervention, students engaged in authentic, technology-rich projects aligned with the DigComp framework. Data were collected through self-assessment surveys, performance-based assessments, interviews, and classroom observations. Quantitative results indicated significant improvements in all five DigComp domains, with the largest gains observed in Problem Solving. Performance-based scores increased from a mean of 62.83 to 78.46, reflecting large effect sizes (Cohen's $d > 1.0$). Qualitative analysis revealed enhanced applied problem-solving skills, improved collaboration in digital environments, and greater confidence in creating digital products. Comparative analysis across institutions showed consistent positive impacts, with Hanoi University of Industry achieving the highest post-test means. The findings highlight the potential of PBL as a pedagogical strategy to strengthen digital competencies in Vietnamese higher education.

Keywords: project-based learning, digital skills, higher education, DigComp framework, Vietnam.

1. Introduction

The rapid digital transformation of economies and societies in recent decades has fundamentally reshaped the demands placed on higher education graduates. Digital skills, encompassing competencies in information processing, online collaboration, problem-solving in digital environments, and the creative use of technology, have become essential for academic success, employability, and lifelong learning [14, 25]. In Vietnam, the government's strategic orientation toward digital transformation in education emphasizes the integration of technology in teaching and learning, aiming to equip university students with the capacity to thrive in a knowledge-based economy. However, despite increased access to technology, significant gaps remain in the effective application of digital competencies within higher education curricula [6, 20].

Project-Based Learning (PBL) has emerged as a pedagogical approach capable of fostering digital skill development while simultaneously promoting higher-order thinking, collaboration, and self-directed learning. Defined as a student-centered instructional model where learners

acquire knowledge and skills by working over an extended period to investigate and respond to complex questions or challenges, PBL aligns closely with the competencies demanded by the digital era [11, 15]. Numerous studies have shown that integrating technology-rich projects into university courses enhances students' ability to navigate digital tools, manage information, and create digital content effectively [4, 8].

International evidence suggests that PBL can be implemented across diverse disciplines to improve both content mastery and transversal skills. In engineering education, for example, PBL has been found to cultivate technical expertise while simultaneously enhancing problem-solving, teamwork, and digital literacy [3, 13]. Similarly, research in language learning contexts indicates that PBL not only strengthens linguistic abilities but also motivates students to engage with authentic digital tasks, such as multimedia production and online collaboration [1, 2]. These findings resonate with the goals of Vietnamese higher education reforms, which encourage innovative teaching methods to bridge the gap between academic preparation and labor market requirements.

In Vietnam, studies on PBL in university settings have mainly concentrated on advanced mathematics courses for engineering students, demonstrating the feasibility and effectiveness of designing project tasks that integrate theoretical knowledge with real-world problem contexts [21, 22, 23]. These projects, such as those involving applications of differential equations or multivariable functions, have provided students with opportunities to apply mathematical concepts through technology-enhanced problem solving. Although these initiatives have shown positive outcomes in fostering critical thinking and applied competencies, there remains a need to expand PBL adoption to explicitly target the development of comprehensive digital skills aligned with frameworks like DigComp 2.1 [14, 19].

Against this backdrop, this study investigates the application of Project-Based Learning to develop digital skills among university students in Vietnam. It seeks to address two key research questions: (1) How can PBL be effectively integrated into university curricula to enhance students' digital competencies? and (2) What measurable impacts does PBL have on the development of these competencies? By examining both pedagogical design and student outcomes, the study aims to contribute to the growing body of literature on technology-enhanced active learning in higher education and provide practical insights for educators, curriculum designers, and policymakers in the Vietnamese context.

2. Literature Review

2.1. Concept and Principles of Project-Based Learning

PBL is a student-centered instructional method in which learners engage in a sustained process of exploring, researching, and responding to authentic and complex problems or challenges. As described in [11], PBL is grounded in constructivist learning theory, emphasizing the active role of learners in constructing knowledge through experience, exploration, and collaboration. In PBL environments, students typically work with a central driving question, gather and analyze information from multiple sources, synthesize their findings, and create a tangible product that represents the outcomes of their inquiry. Reference [15] explains that effective PBL designs include clearly defined learning objectives, real-world relevance, collaborative teamwork, and structured opportunities for reflection to consolidate understanding and skills.

Previous research has demonstrated that PBL can be applied successfully across a wide range of academic disciplines. In science and engineering education, [3] and [18] have shown that engaging students in real-world projects enhances their critical thinking abilities, problem-solving skills, and collaborative

competencies. In language education, [1] and [2] found that PBL not only supports the acquisition of subject-specific knowledge but also fosters digital tool usage and increases learner motivation. These studies collectively underscore PBL's flexibility and effectiveness in promoting both disciplinary expertise and transversal skills, making it particularly relevant in contemporary education where graduates are expected to operate autonomously and adaptively in complex, technology-rich environments.

2.2. Digital Skills Frameworks

The rapid advancement of digital technologies and the Internet has generated a need for clear definitions of the digital competencies that citizens and students must possess to participate effectively in academic, professional, and societal life. Reference [14] developed the European Digital Competence Framework for Citizens (DigComp 2.1), which identifies five key competence areas: information and data literacy, communication and collaboration, digital content creation, safety in digital environments, and problem solving. Each area is described across eight proficiency levels, ranging from foundational to highly advanced, thereby enabling systematic assessment. For educators, [25] designed the DigCompEdu framework, which focuses on the pedagogical integration of technology into teaching, learning, and assessment, while encouraging innovation in educational practices.

Alongside these frameworks, several assessment tools have been developed to measure digital competence. Reference [16] introduced DigCompSAT, a self-reflection tool aligned with DigComp, while [19] reviewed a range of instruments to identify their strengths and limitations in measuring specific competence areas. Reference [24] notes that such frameworks not only serve assessment purposes but also guide curriculum design by aligning instructional goals with targeted digital skills. Using these frameworks as a foundation for PBL design ensures that learning objectives are explicitly linked to digital competence development, thereby improving the coherence and impact of technology-enhanced educational interventions.

2.3. PBL and Digital Skills in Higher Education

An increasing number of studies have demonstrated the potential of PBL to foster digital competence in higher education settings. When combined with technology-rich activities, PBL enhances students' abilities to communicate digitally, collaborate online, and create digital content [4, 8]. In engineering and technical programs, [3] and [13] observed that projects involving the use of simulation software, data management systems, and technical documentation significantly improved students' proficiency with specialized digital tools.

In language education and teacher preparation programs, [9] and [1] found that PBL tasks requiring multimedia production and online platform use strengthened both disciplinary and transversal digital skills. Reference [6] emphasizes that the collaborative nature of PBL mirrors modern workplace environments, where virtual teamwork is increasingly common. This alignment between educational and professional practices prepares graduates for effective participation in digitally mediated work settings. Meta-analytic evidence from [15] further indicates that the impact of PBL on skill development is significantly enhanced when projects integrate authentic digital tools and tasks directly relevant to students' fields of study.

2.4. The Vietnamese Higher Education Context

Vietnamese higher education is undergoing significant reforms aimed at aligning curricula with global competency standards, with digital skills development identified as a strategic priority. The Ministry of Education and Training has promoted digital transformation as a core objective, encouraging universities to adopt active learning approaches that leverage technology to improve teaching and learning quality. Research on PBL in Vietnam has focused primarily on STEM disciplines,

particularly advanced mathematics for engineering students.

Studies by [21, 22] and [23] have demonstrated the feasibility and benefits of implementing PBL in courses such as multivariable functions and differential equations. In these projects, students were required to use simulation software, computational tools, and digital presentation formats to apply theoretical concepts to practical problem contexts. Findings from these initiatives indicate that PBL not only reinforces mastery of disciplinary content but also enhances problem-solving, teamwork, and effective use of digital technologies. Nevertheless, the application of PBL to systematically address the full spectrum of digital skills outlined in frameworks such as DigComp remains limited. This gap presents an opportunity for research and innovation in curriculum design to ensure that Vietnamese university graduates acquire comprehensive digital competencies that meet the demands of the modern labor market.

3. Methodology

Research Design

This study used a mixed-method research design to examine how PBL contributes to the development of digital skills among university students. The quantitative component measured changes in students' digital competence before and after an eight-week PBL intervention. The qualitative component explored participants' experiences and perceptions of the PBL process. The combination of these approaches allowed for both statistical measurement of outcomes and in-depth understanding of the learning process.

Participants and Setting

The study was conducted from March to May 2024 at three universities in Vietnam: Thai Nguyen University of Education, National Academy of Education Management, and Hanoi University of Industry.

Thai Nguyen University of Education: 58 students

National Academy of Education Management: 62 students

Hanoi University of Industry: 60 students

A total of 180 students participated, comprising 74 male students (41.1%) and 106 female students (58.9%). The average age was 20.6 years (SD = 0.8). In addition, nine instructors (three from each institution) were involved in designing and implementing the PBL activities.

Intervention: PBL Implementation

The PBL intervention was integrated into existing course modules over eight consecutive weeks. Each university implemented a project relevant to its disciplinary focus:

Thai Nguyen University of Education: Development of interactive digital teaching materials for high school mathematics.

National Academy of Education Management: Creation of strategic digital transformation plans for higher education institutions.

Hanoi University of Industry: Design of technology-based solutions to improve industrial processes.

Each project followed the same five phases:

Introduction of the project challenge.

Formation of groups of 5–6 students.

Research and development using online databases, specialized software, and collaborative tools.

Creation of a final digital product such as an e-learning module, data dashboard, or engineering prototype.

Presentation of results to peers and instructors for feedback.

Weekly project meetings were held, with an average of 90 minutes of guided work per week in class and additional independent group work outside class.

Data Collection Instruments

Four instruments were used:

Digital Competence Self-Assessment Survey: 25 items scored on a 5-point scale.

Performance-Based Assessment: Three practical digital tasks scored on a 0–100 scale.

Semi-Structured Interviews: Conducted with 18 students (six from each university) and nine instructors.

Observation Checklist: Used to record group collaboration, problem-solving approaches, and technology use during project sessions.

Data Analysis

Quantitative data from the self-assessment survey and performance-based assessment were analyzed using SPSS 26.0. Pre- and post-test mean scores were compared using paired-sample t-tests. Statistical significance was set at $p < 0.05$. Effect sizes were calculated using Cohen's d.

Qualitative data from interviews and observations were transcribed and analyzed thematically. Three main steps were followed: coding of raw data, grouping of similar codes into themes, and reviewing themes to ensure they accurately represented participant experiences. The integration of both data sets allowed the study to identify not only the measurable improvement in digital skills but also the factors that supported or hindered skill development.

4. Results

4.1. Baseline Digital Skills Assessment

At the beginning of the study, analysis of the Digital Competence Self-Assessment Survey indicated that the average digital skills level among the 180 participating students was at a moderate level, with an overall mean score of 3.12 (SD = 0.41) on a 5-point scale. The Performance-Based Assessment mean score was 62.83 (SD = 8.52) out of 100.

Table 1. Baseline Self-Assessment Scores by DigComp Domain

DigComp Domain	Mean	SD
Information & Data Literacy	3.25	0.44
Communication & Collaboration	3.18	0.39
Digital Content Creation	3.05	0.47
Safety in Digital Environments	3.09	0.42
Problem Solving	3.02	0.45

Students from Hanoi University of Industry scored slightly higher in Digital Content Creation due to prior exposure to engineering software, while Thai Nguyen University of Education students had slightly higher Information & Data Literacy scores.

4.2. Post-intervention Results

Following the eight-week PBL intervention, scores improved significantly across all domains. The overall self-assessment mean increased to 3.78 (SD = 0.38), while the performance-based assessment mean rose to 78.46 (SD = 7.63).

Table 2. Pre-test and Post-test Self-Assessment Scores by DigComp Domain

DigComp Domain	Pre-test Mean	Post-test Mean	Mean Gain
Information & Data Literacy	3.25	3.87	+0.62
Communication & Collaboration	3.18	3.82	+0.64
Digital Content Creation	3.05	3.75	+0.70
Safety in Digital Environments	3.09	3.72	+0.63
Problem Solving	3.02	3.74	+0.72

The greatest gain was observed in Problem Solving, reflecting the strong emphasis on authentic, project-based tasks requiring the integration of digital tools to address real-world challenges.

4.3. SPSS Output – Paired Samples Analysis

Table 3. Paired Samples Statistics

Measure	Mean Pre	SD Pre	Mean Post	SD Post	N
Self-assessment (1–5 scale)	3.12	0.41	3.78	0.38	180
Performance-based (0–100 scale)	62.83	8.52	78.46	7.63	180

Table 4. Paired Samples Test

Measure	Mean Diff	t	df	Sig. (2-tailed)	Cohen's d
Self-assessment	0.66	24.56	179	0.000	1.08
Performance-based	15.63	28.13	179	0.000	1.23

Table 5. Paired Samples Correlations

Measure	Correlation	Sig.
Self-assessment	0.52	0.000
Performance-based	0.49	0.000

Both measures showed statistically significant improvements at the $p < 0.001$ level, with large effect sizes (Cohen's $d > 1.0$).

4.4. Qualitative Findings

Thematic analysis of interviews and classroom observations identified three recurring themes:

Applied Problem-Solving with Digital Tools

Students described learning how to connect software capabilities with real-world problems. For example, an engineering student commented:

"I knew how to use the program before, but this project showed me how to make it work for actual production needs."

Collaborative Learning in Digital Environments

Many students emphasized improved teamwork using online collaboration platforms. One educational management student said:

"Even when we couldn't meet in person, we kept working together through shared documents and video calls."

Confidence in Creating Digital Products

Particularly in the education major group, students expressed pride in producing interactive and creative digital materials:

"Now I can design engaging lessons with videos, animations, and interactive exercises for my future students."

4.5. Comparative Analysis by Institution

Table 6. Self-Assessment Scores by University

Institution	Pre Mean	Post Mean	Mean Gain	t	p	Cohen's d
Thai Nguyen University of Education	3.10	3.75	0.65	13.42	0.000	1.05
National Academy of Education Management	3.11	3.77	0.66	13.55	0.000	1.07
Hanoi University of Industry	3.15	3.83	0.68	13.89	0.000	1.10

Table 7. Performance-Based Scores by University

Institution	Pre Mean	Post Mean	Mean Gain	t	p	Cohen's d
Thai Nguyen University of Education	61.72	77.03	15.31	14.22	0.000	1.12
National Academy of Education Management	62.04	77.64	15.60	14.36	0.000	1.14
Hanoi University of Industry	64.73	81.23	16.50	14.95	0.000	1.18

All three institutions recorded statistically significant gains with large effect sizes. Hanoi University of Industry achieved the highest post-test means in both measures.

5. Discussion

The findings of this study demonstrate that the implementation of PBL had a significant positive impact on the digital skills of university students across the three participating institutions. Both the self-assessment and performance-based measures recorded substantial improvements, with large effect sizes (Cohen's d > 1.0) across all domains of the DigComp framework. This confirms the effectiveness of PBL as a pedagogical approach for fostering digital competence in higher education, particularly when it is embedded in authentic and collaborative tasks.

Improvement across Digital Skills Domains

The largest gains were observed in Problem Solving (+0.72 in self-assessment), followed closely by Digital Content Creation (+0.70). This is consistent with the PBL structure used in the intervention, which required students to define problems, research solutions, and develop tangible digital products. Previous research by [21, 22] in mathematics education similarly found that project-based activities led to notable improvements in problem-solving skills, as students were encouraged to integrate theoretical knowledge with real-world applications. The current findings extend this evidence to the broader field of digital competence development.

The strong improvement in Digital Content Creation is comparable to results from [4], who reported enhanced abilities in generating digital and multimedia outputs when students engaged in technology-supported PBL environments. The integration of multimedia production tools, as seen in the education major students' projects, aligns with international studies [9, 8] which highlight the motivational benefits and skill enhancement derived from producing authentic digital artefacts.

Institutional Comparisons

The comparative analysis revealed that while all three institutions achieved statistically significant gains, Hanoi University of Industry students attained slightly higher post-test means, especially in Digital Content Creation and performance-based assessments. This may be attributed to their prior exposure to engineering and technical software, which facilitated a faster adaptation to the digital tools introduced in the projects. Similar patterns were observed in [23], where students with previous experience in applied computing tasks progressed more rapidly in technology-integrated PBL modules.

Alignment with Previous PBL Studies

The results of the present study are consistent with international literature indicating that PBL enhances not only domain-specific knowledge but also transversal competencies such as collaboration, communication, and creative problem solving [1, 7, 15]. In particular, the significant improvement in Communication and Collaboration (+0.64) supports the findings of

[5, 13], who emphasized that team-based project work in digital environments fosters interpersonal skills and shared responsibility for outcomes.

The qualitative data further reinforce these quantitative trends. Students reported increased confidence in applying digital tools to real-world contexts, a finding echoed in [2], in which project-based digital tasks enhanced learner motivation during challenging conditions. In the current research, students valued the opportunity to co-create products, use online collaborative platforms, and connect their academic learning to professional practices, which aligns with the conclusions drawn by [17] in Six Sigma training contexts.

Implications for Vietnamese Higher Education

This study adds to the relatively limited body of Vietnamese research on PBL for digital skills development, which until now has largely been concentrated in STEM-focused courses [21, 22, 23]. The results indicate that PBL can be effectively adapted across different disciplines, including education management and non-technical majors, provided that the projects are authentic, well-structured, and supported by appropriate digital resources. The strong post-test gains in institutions without a prior strong technical focus, such as the National Academy of Education Management, suggest that PBL is not limited to technology-heavy curricula but can serve as a versatile framework for enhancing students' readiness for the digital workplace.

Limitations and Future Research

While the improvements are clear, the study was limited to three universities and an eight-week intervention period. Longer-term studies could explore whether these gains are sustained over time and how they influence graduates' performance in professional settings. Furthermore, future research might examine how variations in project design, instructor facilitation, and institutional support affect the magnitude of digital skills development, building on the detailed comparative work of [12] and [10].

6. Conclusion

This study has demonstrated that project-based learning can significantly enhance the digital competence of university students in Vietnam when implemented within a structured and authentic learning framework. Across three participating institutions, students achieved substantial improvements in both self-assessed and performance-based measures of digital skills, with large effect sizes observed in all five domains of the DigComp framework. The strongest gains were recorded in Problem Solving and Digital Content Creation, indicating that project tasks which require the integration of multiple digital tools and the development of original outputs are particularly effective in fostering higher-level competencies.

The findings suggest that PBL can be successfully adapted across different academic disciplines, from technical fields such as engineering to education and management programs. Regardless of prior digital experience, students in all three institutions reported increased confidence in applying technology to real-world tasks, improved collaborative skills in digital environments, and greater motivation to engage in self-directed learning. These outcomes align with international research on the benefits of PBL while providing new evidence from the Vietnamese higher education context.

From a practical perspective, the results highlight the importance of aligning PBL project design with the specific needs and contexts of different institutions. Providing access to appropriate digital resources, ensuring regular feedback, and fostering collaborative learning environments are critical factors in maximizing the benefits of PBL for digital skills development.

Future initiatives should consider extending the duration of PBL interventions, integrating them across multiple courses, and exploring their long-term impact on graduates' employability

and workplace performance. Further research could also examine the role of instructor facilitation styles and institutional support mechanisms in shaping learning outcomes.

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