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Integrating PjBL and Microlearning to Support TCK Development in Pre-Service Language Teachers: A Narrative Literature Review

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Abstract:

The integration of digital technology in language education requires pre-service teachers not only to master technology but also to connect it with instructional content through *Technological Content Knowledge* (TCK). *Project-Based Learning* (PjBL) provides an authentic context for applying technology, but project complexity can place demands on learners' technological readiness. *Microlearning*, meanwhile, supports focused learning of technological knowledge and procedures, yet its functional relationship with PjBL remains unclear. This study aims to synthesize the literature on PjBL and *Microlearning* and examine their potential complementary relationship in supporting TCK development among pre-service language teachers. A *narrative literature review* with *thematic synthesis* was conducted on 35 Scopus-indexed articles published between 2021 and 2026, comprising 18 *Microlearning* studies and 17 PjBL studies, including 10 studies focusing on pre-service language teachers. The synthesis indicates that PjBL facilitates skill development through project activities but can present challenges related to technological readiness; *Microlearning* supports focused learning of technology and procedures; and a functional gap exists between the two approaches. Drawing on TPACK/TCK, *scaffolding*, and *Cognitive Load Theory*, *Microlearning* is conceptually positioned as a *prerequisite cognitive scaffold* before relevant PjBL activities. This proposition reframes *Microlearning* as preparatory technological support that may facilitate technology-content integration and TCK development, while its effectiveness remains to be empirically examined.

Keywords: Technological Content Knowledge; Project-Based Learning; Microlearning; Pre-Service Language Teachers; Cognitive Scaffolding; Teacher Education

Introduction

The integration of digital technology in language education requires pre-service language teachers to develop more than basic technological skills. They need to understand how technological affordances relate to the characteristics of particular content and learning objectives. Within the Technological Pedagogical Content Knowledge (TPACK) framework, this competence is reflected in Technological Content Knowledge (TCK), which concerns the relationship between technology and content (Koehler & Mishra, 2009; Mishra & Koehler, 2006). Developing TCK therefore involves not only operating digital tools but also making informed decisions about their use for particular content.

Project-Based Learning (PjBL) provides a context for such development because it engages learners in authentic activities involving planning, designing, producing artifacts, problem solving, collaboration, and technology use. Studies in teacher education and pre-service language teacher education have reported project activities that support technology-related competencies, instructional design, and authentic production (Belda-Medina, 2024; Poonpon, 2022; Tristiana et al., 2024; D. Zhang & Wang, 2023). However, project-based activities can also place substantial technological and procedural demands on learners. Technical barriers, limited prior knowledge of digital tools, and reliance on familiar technologies may affect their ability to focus on broader pedagogical and content-related decisions (Max et al., 2024; Pedrosa, 2024; D. Zhang & Wang, 2023). The presence of technology in PjBL, therefore, does not necessarily mean that learners have sufficient technological readiness.

Microlearning provides a focused approach to learning specific knowledge, procedures, or skills. Previous studies have associated Microlearning with targeted and procedural learning, digital competence development, and technology-supported learning (Betancur-Chicué & García-Valcárcel Muñoz-Repiso, 2023; Nurdianti et al., 2026; Sathiyaseelan et al., 2024; Taylor & Hung, 2022). Research in teacher and language education has also examined Microlearning for professional development, technology-related learning, and self-directed learning (Kohnke, 2025; Kohnke & Moorhouse, 2024; Lucas Kohnke et al., 2024). These studies support its use for focused technological learning, but they do not establish how Microlearning can prepare learners for the technological demands of subsequent PjBL activities.

The issue is therefore functional rather than quantitative. Research on PjBL and Microlearning is substantial, but their instructional functions have largely been examined separately. PjBL emphasizes complex learning, authentic production, collaboration, problem solving, and technology application, whereas Microlearning is commonly used for focused, flexible, procedural, supplementary, or just-in-time learning (Monib, Qazi, Apong, et al., 2025; Taylor & Hung, 2022; L. Zhang & Ma, 2023). The reviewed literature does not clearly articulate how focused technological learning through Microlearning can be aligned with the specific technological demands that arise during PjBL activities.

This gap is relevant to pre-service language teacher education because TCK requires learners to move beyond operational technology skills toward understanding how technology can be connected appropriately to particular content. This study therefore synthesizes literature on PjBL and Microlearning and examines their potential complementary relationship in supporting TCK development among pre-service language teachers. Using a narrative literature review with thematic synthesis, the study identifies patterns concerning the functions of PjBL, technological readiness demands, the role of Microlearning in focused technological learning, and the functional relationship between the two approaches. The review contributes a conceptual account of how Microlearning may be positioned in relation to technological demands within

PjBL, while recognizing that this relationship remains a literature-based proposition that requires empirical examination.

Methods

This study employed a narrative literature review with *thematic synthesis*. The *narrative literature review* was used to organize and interpret the literature based on the focus of the study (Green et al., 2006), while *thematic synthesis* was used to identify patterns and analytical themes across study findings (Thomas & Harden, 2008). Data were collected through the search and selection of English-language scientific articles indexed in Scopus and published between 2021 and 2026. Of the 37 publications initially identified, 2 were excluded because they did not meet the Scopus indexing or publication-period criteria, resulting in 35 articles, comprising 18 Microlearning articles and 17 PjBL articles, with 10 articles focusing on pre-service language teachers.

The data consisted of secondary findings and information related to technological knowledge and readiness, technology-content integration, TCK/TPACK, learning challenges, and pedagogical support. The data were extracted, organized into descriptive categories, and compared across studies to identify patterns, themes, and the functional relationship between Microlearning and PjBL. The synthesis was then used to formulate a conceptual proposition positioning Microlearning as a *prerequisite cognitive scaffold* before relevant PjBL activities to support technological readiness and TCK development.

Results And Discussion

Project-Based Learning Facilitates Skill Development through Project Activities

The synthesis of 17 PjBL studies indicates that PjBL provides an active learning environment in which skills develop through direct engagement in project activities. Projects require learners to plan, design, produce artifacts, solve problems, and collaborate with others. In teacher education, these characteristics are relevant because project activities resemble authentic tasks that pre-service teachers may encounter when designing and producing instructional materials.

Several studies report that PjBL supports language-related skills through activities involving planning, production, problem solving, and collaboration (Belda-Medina, 2024; Poonpon, 2022; Tristiana et al., 2024; Yusupova et al., 2025). Similar patterns appear in studies of teacher education and other educational contexts, where PjBL involves learners in producing tangible outputs, solving contextual problems, and applying knowledge through project work (Al-Busaidi & Al-Seyabi, 2021; Erviana et al., 2022; García-Sampedro et al., 2026; Setuju et al., 2024; D. Zhang & Wang, 2023). Other studies also report the use of technology within project activities, including digital tools and technology-supported production tasks (Chimwayange, 2025; Kurniawan et al., 2025; Martinez, 2022; Max et al., 2024; L. Zhang & Ma, 2023).

However, PjBL does not in itself produce TCK. The evidence more appropriately indicates that PjBL provides a context in which technological knowledge can be used in content-related tasks. TCK development still depends on how learners use technology to make decisions that correspond to the characteristics of the content. The strength of PjBL as an application environment therefore needs to be considered alongside the technological readiness required during project activities.

Technological Readiness Can Become a Challenge in PjBL Activities

The synthesis also indicates that complex PjBL environments may require technological readiness that learners do not necessarily possess at the beginning of a project. Max et al. (2024), for example, identified technical barriers that can affect learners' participation in technology-supported project activities (Max et al., 2024).

Pedrosa (2024) reported the relevance of prior digital knowledge, while Zhang and Wang (2023) highlighted the role of learners' familiarity with technology (Pedrosa, 2024; D. Zhang & Wang, 2023). Similar concerns appear in studies showing that project-based activities can involve multiple technological, procedural, and production-related demands (Chimwayange, 2025; García-Sampedro et al., 2026; Kurniawan et al., 2025; Li et al., 2024).

These findings do not indicate that PjBL is ineffective. Rather, they show that opportunities to use technology during projects do not necessarily mean that learners already possess sufficient technological readiness. When learners must operate unfamiliar technology, understand project requirements, make content-related decisions, and produce an artifact at the same time, limited technological knowledge or procedural skills may increase the attention required for operational tasks. This may leave less attention available for more complex decisions concerning the relationship between technology and content.

The evidence should be interpreted within the scope of the reviewed literature. Studies conducted in different educational contexts provide supporting evidence about the technological and cognitive demands of project activities, but they do not directly establish TCK-related challenges among pre-service language teachers. The relevance of these findings lies in identifying technological readiness as one condition that may influence learners' participation in technology-supported project work.

Microlearning Supports Focused Learning of Technology and Procedures

The synthesis of 18 Microlearning studies shows a consistent pattern of learning organized into focused units addressing specific knowledge, concepts, procedures, or skills. Taylor and Hung (2022) describe Microlearning as suitable for targeted and just-in-time learning, while Nurdyanti (2026) and Alshammari (2024) report its use for focused learning activities (Alshammari, 2024; Nurdyanti et al., 2026; Taylor & Hung, 2022). Other studies highlight its relevance to procedural learning, performance, and technology-supported learning (Al-Zahrani, 2024; Betancur-Chicué & García-Valcárcel Muñoz-Repiso, 2023; Conde-Caballero et al., 2024; Mahendra & Killis, 2025; Naser, 2024; Sathiyaseelan et al., 2024).

Research in teacher education also reports the use of Microlearning for professional development, technology-related learning, and self-directed learning (Al-khresheh et al., 2025; Kohnke, 2025; Kohnke & Moorhouse, 2024; Lucas Kohnke et al., 2024; Monib, Qazi, & Apong, 2025; Monib, Qazi, Apong, et al., 2025). Fidan (2023) further illustrates how Microlearning can be incorporated into a flipped learning environment, suggesting that its focused format can complement broader instructional arrangements (Fidan, 2023).

Across the reviewed corpus, the evidence is stronger for the use of Microlearning to support focused knowledge and procedural learning than for claims about technology-content integration. This distinction is important because the technological knowledge acquired through Microlearning is not equivalent to TCK. The former concerns specific technological knowledge or procedures, whereas the latter involves understanding and applying technology in relation to the characteristics of particular content. This boundary provides the basis for examining the functional relationship between Microlearning and PjBL.

A Functional Gap Exists between Microlearning and PjBL

The synthesis indicates that PjBL and Microlearning serve different instructional functions. PjBL provides an environment for complex learning through authentic production, problem solving, collaboration, and technology application, whereas Microlearning organizes learning into focused units addressing specific knowledge,

procedures, or skills. The gap identified in the literature is not the general effectiveness of either approach, but how their different functions can be connected within a learning sequence.

Several PjBL studies report the use of technological support, preparation, or guidance to help learners manage project demands (Alfurqan et al., 2025; Max et al., 2024; Pedrosa, 2024). However, these studies do not clearly identify Microlearning as a preparatory mechanism linked to the technological requirements of subsequent project activities. Similarly, Microlearning studies commonly examine its use as a flexible, supplementary, self-directed, or just-in-time learning resource, without systematically positioning its content in relation to the specific technological demands of subsequent PjBL activities (Fidan, 2023; Kohnke & Moorhouse, 2024; Monib, Qazi, & Apong, 2025; Monib, Qazi, Apong, et al., 2025; Naser, 2024).

The reviewed literature therefore reveals a functional gap between focused technological learning and the technological demands of complex project work. Evidence supports these two functions separately, but their deliberate alignment within a learning sequence has not been clearly articulated. This gap provides the analytical basis for examining the potential relationship between Microlearning and PjBL in the following section.

Analysis

The findings from the thematic synthesis are interpreted using the Technological Pedagogical Content Knowledge (TPACK) framework, particularly Technological Knowledge (TK) and Technological Content Knowledge (TCK), together with perspectives from scaffolding and Cognitive Load Theory. Thematic synthesis identifies patterns across studies, while these theoretical perspectives are used to explain their meaning and functional relationships. This section does not introduce new empirical findings but develops a conceptual interpretation of the literature.

The findings can be understood through the distinction between Technological Knowledge (TK) and Technological Content Knowledge (TCK). Mishra and Koehler (2006) and Koehler and Mishra (2009) define TCK as knowledge of the relationship between technology and the characteristics of content (Koehler & Mishra, 2009; Mishra & Koehler, 2006). TCK therefore differs from the ability to operate digital devices or perform technological procedures. It concerns understanding how the characteristics of a technology can be used to represent, access, or facilitate learning of particular content. Lucas Kohnke et al. (2024) found that improvements in technical competence do not automatically lead to more transformative digital practices, reinforcing the distinction between technical readiness and integrative competence (Lucas Kohnke et al., 2024).

Within this framework, PjBL can be understood as an application context that gives learners opportunities to mobilize TK in content-related tasks. Evidence from Zhang and Wang (2023), Erviana et al. (2022), and Setuju et al. (2024) indicates a relationship between PjBL activities and the development of TPACK/TCK-related competencies in teacher education (Erviana et al., 2022; Setuju et al., 2024; D. Zhang & Wang, 2023). However, PjBL activities do not automatically produce TCK. TCK development depends on how technology is used in ways that consider the characteristics and needs of the content. Technological readiness therefore provides a relevant foundation for such activities, but TK should not be equated with TCK.

From this perspective, Microlearning and PjBL serve different but potentially complementary functions. Microlearning can support TK and procedural readiness, particularly when its content targets specific technological knowledge or skills. PjBL provides an authentic context in which this knowledge can be applied to content-based

tasks. When learners use technology while considering the characteristics of the content, technology-content integration takes place, which is conceptually related to TCK development. This relationship is an interpretation across studies rather than an empirically established causal sequence.

The perspective of scaffolding helps explain why focused technology learning may be placed before project activities. Van de Pol et al. (2010) describe scaffolding as support that helps learners perform tasks they cannot yet complete independently (Van De Pol et al., 2010). Microlearning is not automatically a form of scaffolding. It can function as a scaffold when its content and form of support are aligned with learners' needs and the demands of the task they are expected to perform. Its status as a *prerequisite cognitive scaffold* therefore depends not simply on the Microlearning format but on the relevance of the technological content to the subsequent project demands.

Findings on Microlearning for procedural learning support this interpretation. Taylor and Hung (2022) highlight the relevance of *Just-in-Time Microlearning* for procedural learning, while Sathiyaseelan et al. (2024) report a relationship between Microlearning, *extraneous cognitive load*, and learning performance (Sathiyaseelan et al., 2024; Taylor & Hung, 2022). These findings are relevant to procedural technological demands in PjBL, such as operating software, producing digital artifacts, or using particular features. Focused learning addressing these requirements before a project can therefore be understood as preparatory support.

This interpretation can be further considered through Cognitive Load Theory. Sweller (2011) and Van Merriënboer and Sweller (2005) emphasize the limited capacity of working memory during complex learning and the importance of managing unnecessary demands (Sweller, 2011; Van Merriënboer & Sweller, 2005). In PjBL, learners may need to understand project goals, consider content characteristics, coordinate with group members, make decisions, produce an artifact, and operate technology at the same time. When technological procedures are unfamiliar, these operational demands may add to task complexity. Focused technology learning before the project therefore has a theoretical basis as a form of preparation.

This relationship, however, requires careful qualification. The reviewed literature does not directly test whether Microlearning provided before PjBL reduces *extraneous cognitive load* during the project or improves TCK. Cognitive Load Theory therefore functions as an interpretive lens, not as evidence that cognitive load reduction has occurred in the Microlearning-PjBL relationship. The theory is used to explain why acquiring relevant technological knowledge and procedures before a complex activity may be conceptually useful, not to claim that Microlearning necessarily reduces cognitive load during PjBL.

The term prerequisite cognitive scaffold is used here in a specific sense. *Prerequisite* refers to support provided before learners encounter relevant technological demands in a project. *Cognitive* indicates that the support focuses on knowledge or procedures required to perform the task. *Scaffold* refers to support intended to help learners enter a more complex activity. This position is consistent with the principle that scaffolding should respond to task demands and learner needs rather than being defined solely by the format of the learning material.

Microlearning is therefore not positioned as a direct mechanism for TCK development. Its more limited function is to prepare relevant technological knowledge and procedures before learners use technology in PjBL activities. PjBL then provides the environment in which this knowledge can be applied to content-related tasks. Through this application, technology use can move beyond operational competence toward consideration of how technology fits the characteristics of the content, which is relevant

to TCK development. Whether positioning Microlearning as prerequisite support produces better technology–content integration or TCK remains an empirical question.

Based on the thematic synthesis and its interpretation through TPACK/TCK, scaffolding, and Cognitive Load Theory, this study proposes a conceptual proposition concerning the functional relationship between Microlearning and PjBL. The proposition is not a validated instructional model and does not establish a causal relationship. It represents an interpretation of the functions identified across the two bodies of literature.

Conceptually, Microlearning is placed before relevant technological demands within PjBL, particularly when learners require specific technological knowledge or procedures to complete a project. This support is expected to strengthen TK and technological readiness. PjBL then provides an authentic application environment in which technology is used for content-related tasks. Through this process, technology use can move beyond operational skills toward consideration of the suitability of technology for particular content characteristics, which is conceptually related to TCK development.

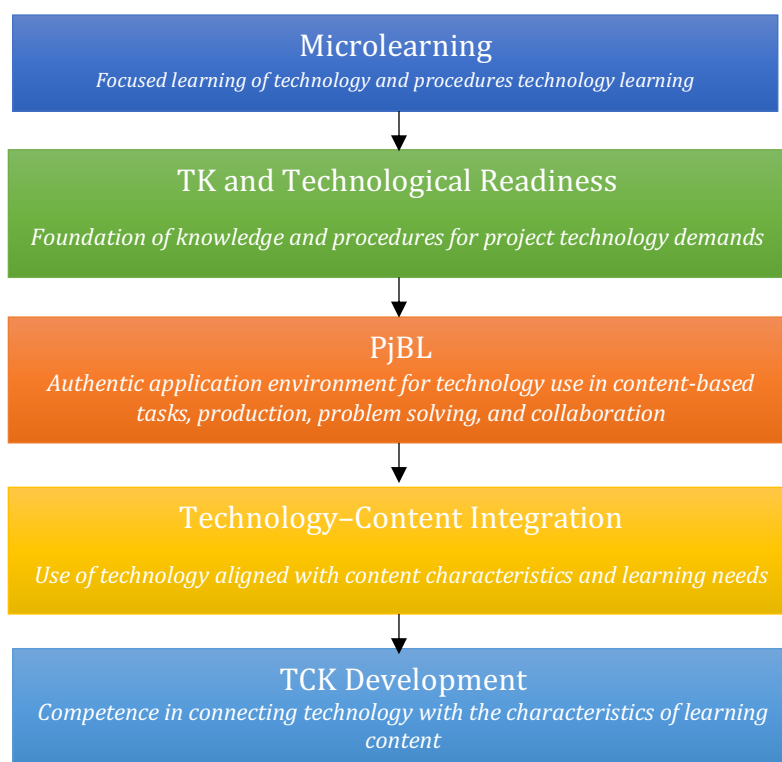


Figure 1. Conceptual proposition for positioning Microlearning as a *prerequisite cognitive scaffold* within PjBL to support TCK development

Figure 1 illustrates that Microlearning is conceptually positioned as a prerequisite support for strengthening TK and technological readiness before learners encounter technological demands in PjBL. PjBL remains the primary environment for applying technology in content-based tasks, while technology–content integration is positioned as a process related to TCK development.

The conceptual contribution of this review lies in positioning Microlearning as prerequisite support that can be aligned with technological demands within PjBL, rather than simply as additional, parallel, or *just-in-time* learning. PjBL remains the primary environment for complex learning and the application of technology to content-based

tasks. Microlearning serves a preparatory function when specific technological knowledge or procedures need to be acquired before the corresponding project demands arise.

This proposition also defines the boundary of the study's contribution. The review does not establish that Microlearning before PjBL improves TCK, reduces cognitive load during projects, or produces better technology-content integration than PjBL without such support. Empirical testing or design-based research is therefore needed to determine whether this conceptual relationship can be implemented effectively among pre-service language teachers.

Conclusion

This narrative literature review of 35 Scopus-indexed publications published between 2021 and 2026 indicates that PjBL and Microlearning have different but potentially complementary instructional functions in supporting TCK development among pre-service language teachers. PjBL provides an authentic environment for applying technology in content-related activities, while Microlearning supports focused learning of technological knowledge and procedures.

Based on the thematic synthesis and theoretical analysis, Microlearning can be conceptually positioned as a *prerequisite cognitive scaffold* to support technological readiness before learners encounter technological demands within PjBL. PjBL then provides a context for applying this knowledge in content-based tasks, which may support technology-content integration and TCK development.

The main contribution of this review is the positioning of Microlearning as prerequisite support that can be aligned with technological demands within PjBL, rather than simply as an additional or parallel learning component. This relationship remains a literature-based conceptual proposition. The review does not establish that providing Microlearning before PjBL reduces cognitive load during projects, improves TCK, or leads to better technology-content integration. Empirical and design-based research is needed to test this proposition among pre-service language teachers.

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