Journal of Movement Learning and Physical Education Pedagogy
ISSN (E): XXXX-XXXX ‖ Vol. 1 No. 2, 2026 ‖ P.040-048
https://cakra-edus.id/index.php/JMLPEP
cesi.journal@gmail.com – journal.jmlpep@cakra.edus.id

Project-Based Learning in Digital Learning: A Literature Review on Collaboration, Creativity, and Learner Autonomy

Delima Mauliyani[1A-E]*, Andi Asti[2B-D], Bhakti Prima Findiga Hermuttaqien[3B-D]
[1,2] Universitas Negeri Makassar, Kota Makassar, Indonesia

Email Corresponding Author: adellmauliyani@gmail.com[1]*

Authors' Contribution:
A. *Conception and design of the study;* ***B.*** *Acquisition of data;* ***C.*** *Analysis and interpretation of data;*
D. *Manuscript preparation;* ***E.*** *Obtaining funding*

Received: 2026-04-23 **Revised**: 2026-05-05 **Accepted**: 2026-05-15

ABSTRACT

Background: Digital learning environments offer opportunities for project-based learning (PjBL), yet technology alone does not ensure collaboration, creativity, or learner autonomy. Objective: This review examines how digital PjBL supports these outcomes and identifies implementation conditions that may strengthen them. Methods: A PRISMA-informed systematic review framework was used to organize evidence on technology-supported PjBL, project phases, and the three focal outcomes. The findings below synthesize reported results from recent reviews, meta-analyses, and empirical studies; their samples represent separate evidence bases and should not be combined as one study sample. Results: A review of 24 technology-integrated K–12 interventions found that initiation and execution were reported in all studies, planning in 88%, and project-closing activities in 46%. A separate meta-analysis of 66 experimental and quasi-experimental papers, producing 190 effect estimates, reported positive PjBL effects on achievement, affective outcomes, and thinking skills, with variation across contexts. A STEM PjBL meta-analysis of eight studies and 13 effect sizes reported a substantial effect on creativity (ES = 3.888, 95% CI [3.609, 4.166]), although heterogeneity was considerable (I^2 = 65%). In an Indonesian online PjBL study involving 80 university students, autonomy was high across four dimensions, while motivation, time management, interaction, and dependence on lecturers remained challenges. Conclusion: Digital PjBL has potential to develop collaboration, creativity, and autonomy when supported by clear roles, meaningful learner choice, feedback, scaffolding, and reflection. These findings are preliminary and should be verified against the final set of ten included articles before being reported as results of that review.

Keyword : Project-Based Learning; Digital Learning; Collaboration; Creativity; Learner Autonomy.

INTRODUCTION

The expansion of digital learning has changed how students access information, communicate, and produce knowledge. Learning management systems, collaborative platforms, multimedia tools, and online resources can connect learners with authentic problems and audiences beyond the classroom. Yet access to technology does not automatically lead to meaningful learning. Digital tools may be used mainly to deliver content or complete routine tasks, leaving students with limited opportunities to investigate problems, make decisions, create products, and reflect on their learning. This challenge raises an instructional question: how can digital learning be designed to develop collaboration, creativity, and learning autonomy together?

Project-based learning (PjBL) offers one possible response. In PjBL, students work over time on a meaningful question or problem, conduct inquiry, apply knowledge, and develop a product or presentation. Collaboration and student agency are central to the approach, while teachers guide the learning process and provide appropriate support (Kokotsaki et al., 2016; Markula & Aksela, 2022).

This is an open-access article under the CC BY-SA license
Copyright © 2026 by Author. Published by Yayasan Cakra Education Sains

When technology is integrated purposefully, it can support research, communication, project planning, feedback, and the creation and sharing of products. Digital environments can therefore extend the processes of PjBL beyond classroom time and location.

However, digital PjBL also presents practical and pedagogical challenges. Students need to coordinate roles, manage deadlines, evaluate online information, and sustain participation across digital channels. Differences in digital access and competence may also affect who contributes to a group project. Recent reviews indicate that technology-integrated PjBL interventions vary in the project phases they include and in how digital tools are used. For example, Hinostroza et al. (2025) found that closing activities such as reflection and revision were less consistently reported than project initiation and execution. In online project work, learner autonomy may be constrained by low motivation, weak time management, limited interaction, or excessive dependence on instructor direction (Learner autonomy in an online project-based learning, n.d.). The central problem, therefore, is not simply whether PjBL or digital technology is effective, but how their integration can support the learning processes and outcomes that matter.

PjBL is generally understood as a student-centered approach in which learning is organized around sustained inquiry and the development of a meaningful product. Its key features include a driving question, learning goals, investigation, collaboration, technology use, and the presentation of tangible outcomes (Kokotsaki et al., 2016; Markula & Aksela, 2022). These features provide a basis for understanding why PjBL may develop skills that are difficult to cultivate through content transmission alone. Students have to negotiate ideas, distribute work, use evidence, and adapt their solutions as a project develops.

Research syntheses report positive effects of PjBL, while also showing that outcomes depend on implementation. Chen and Yang's (2019) meta-analysis found an overall advantage for PjBL over traditional instruction in academic achievement, with effects varying across study conditions. Zhang and Ma's (2023) meta-analysis of 66 experimental and quasi-experimental studies likewise reported positive effects on achievement, affective outcomes, and thinking skills. In higher education, a review of empirical research found that PjBL has been used to investigate a broad range of student outcomes, while also identifying uneven outcome measurement across studies (Guo et al., 2020). These findings support PjBL's potential but caution against treating it as a uniform intervention.

Three outcomes are particularly relevant to the present review. First, collaboration is developed through shared planning, role negotiation, peer feedback, and joint responsibility for a product. It is a learning process as well as a desired outcome: students must communicate and coordinate to make progress. Second, creativity involves generating, evaluating, and refining ideas in response to project constraints. Empirical work on project-based learning has investigated creative thinking in areas such as science and digital product development (e.g., Hwang et al., 2018; Lu et al., 2022; Khaerudin et al., 2026). Third, learning autonomy involves taking responsibility for goals, strategies, time, and progress. Project work can provide opportunities for independent research and decision-making, but these opportunities require clear scaffolding and meaningful student choice (Kokotsaki et al., 2016).

Digital tools may strengthen these processes when their use is aligned with project goals. They can help students find and organize information, share drafts, coordinate tasks, receive feedback, and produce multimedia artifacts. Digital platforms may also allow students to collaborate across locations and present their work to wider audiences. Still, a tool's presence is not evidence of effective integration. Hinostroza et al. (2025) observed that digital technology served different roles across project phases and that its use was often partial. This suggests that research should examine not only which tools are used, but how they support inquiry, collaboration, creative production, and learner decision-making.

Existing research offers evidence about PjBL's academic effects, technology-supported implementations, and individual learning outcomes. Yet these strands are often examined separately. Meta-analyses largely synthesize achievement or broad learning effects (Chen & Yang, 2019; Zhang & Ma, 2023), while studies of technology-integrated PjBL describe digital tools and project phases (Hinostroza et al., 2025). Other work focuses on particular skills or contexts, such as creativity, collaboration, or autonomy. As a result, the relationship among these three outcomes within digital PjBL remains insufficiently synthesized.

A further gap concerns implementation. The same instructional label may describe projects with different levels of student choice, collaboration, teacher guidance, technology integration, and reflection. Such differences may help explain why outcomes vary and why findings do not always transfer across educational levels or subjects. The literature therefore needs a synthesis that connects the design of

digital project work with the ways collaboration, creativity, and learning autonomy are defined, supported, and assessed. This review does not assume that all digital PjBL implementations produce the same outcomes; it examines the conditions and patterns reported in prior studies.

This literature review aims to synthesize research on project-based learning in digital learning contexts, focusing on three outcomes: collaboration, creativity, and learning autonomy. It asks how digital tools are integrated into project phases; what learning processes and instructional conditions are associated with these outcomes; how the outcomes are assessed; and what recurring challenges are reported across studies. The review's contribution is its integrated focus on the relationship between digital project design and these three complementary outcomes. By considering collaboration, creativity, and autonomy together, it can help clarify how digital PjBL supports both social learning and individual agency, and where instructional guidance may be needed. It also brings implementation into the analysis, including the roles of student choice, project structure, feedback, reflection, and digital tools. This synthesis can inform teachers designing technology-supported projects and researchers identifying priorities for future empirical studies. In conclusion, digital PjBL has the potential to create sustained opportunities for students to work together, develop original solutions, and take responsibility for learning. That potential depends on how projects are designed, how technology is used, and how students are supported throughout the process. Synthesizing the literature around collaboration, creativity, and learning autonomy can provide a clearer basis for evaluating current evidence and strengthening digital PjBL practice.

METHODS

This study employed a systematic literature review (SLR) to synthesize conceptual and empirical evidence on project-based learning (PjBL) in digital learning environments, focusing on collaboration, creativity, and learner autonomy. An SLR was selected to support the transparent identification, selection, appraisal, and synthesis of research addressing a defined question (Snyder, 2019; Xiao & Watson, 2019). Reporting followed the PRISMA 2020 framework, which organizes the reporting of records through identification, screening, eligibility assessment, and inclusion (Page et al., 2021). PRISMA was used as a reporting framework; it does not itself determine the quality of the included studies.

The guiding question was: How has digitally supported PjBL been implemented, and what evidence has been reported regarding students' collaboration, creativity, and learner autonomy? Searches were designed for Scopus, Web of Science, ERIC, and Garuda to cover international and Indonesian scholarship. The publication period was January 2016 to October 2026. Search strings combined terms for the instructional approach, digital context, and outcomes: ("project-based learning" OR "project based learning" OR PjBL) AND (digital OR online OR technology OR ICT OR blended OR e-learning) AND (collaboration OR creativity OR autonomy OR "self-directed learning" OR "self-regulated learning"). Syntax was adapted for each database. Reference lists of relevant reviews and primary studies were also checked, consistent with systematic search practices (Xiao & Watson, 2019).

Studies were eligible if they were peer-reviewed journal articles published in English or Indonesian; examined PjBL as a central instructional approach; used digital tools or a digital/online environment during project planning, inquiry, collaboration, production, or presentation; and reported empirical findings or substantive conceptual analysis relevant to at least one focal outcome. Quantitative, qualitative, and mixed-methods designs were eligible. Studies were excluded if they addressed problem-based learning without project-based learning, mentioned technology only incidentally, were editorials or abstracts without adequate methods and findings, or did not address collaboration, creativity, or learner autonomy. This scope recognizes that technology-integrated PjBL varies in project phases and tool use (Hinostroza et al., 2025), and that PjBL outcome research spans achievement, affective, and thinking domains (Chen & Yang, 2019; Zhang & Ma, 2023).

Records were exported to a reference manager and deduplicated before screening. Titles and abstracts were assessed against the eligibility criteria, followed by full-text review of potentially relevant reports. The review was designed to include 10 articles meeting the criteria. To strengthen consistency, two reviewers should independently screen records and assess full texts, resolve disagreements through discussion, and document full-text exclusion reasons. If only one researcher conducts the review, the manuscript should describe the actual checking procedure rather than claim independent screening. Data extracted included author and year, country, educational level, discipline, sample and design, digital tools, project phases, outcome measures, main findings, and limitations. These fields enable comparison

of implementation and measurement, which are important considerations in PjBL research reviews (Guo et al., 2020; Markula & Aksela, 2022).

A structured narrative synthesis was used because differences in educational settings, interventions, instruments, and research designs may make statistical pooling inappropriate. Evidence was coded under the three review outcomes, with inductive subthemes capturing patterns such as role distribution, peer feedback, creative production, self-management, and teacher scaffolding. Findings were compared across educational levels and digital formats. This approach supports synthesis of patterns and conceptual conclusions rather than a simple listing of studies (Siddaway et al., 2019; Snyder, 2019). Collaboration, creativity, and autonomy were treated as related but distinct outcomes. Project work can require collaborative activity, invite original product development, and give learners responsibility for aspects of their progress; however, autonomy depends on project design and instructional support, not technology alone (Kokotsaki et al., 2016).

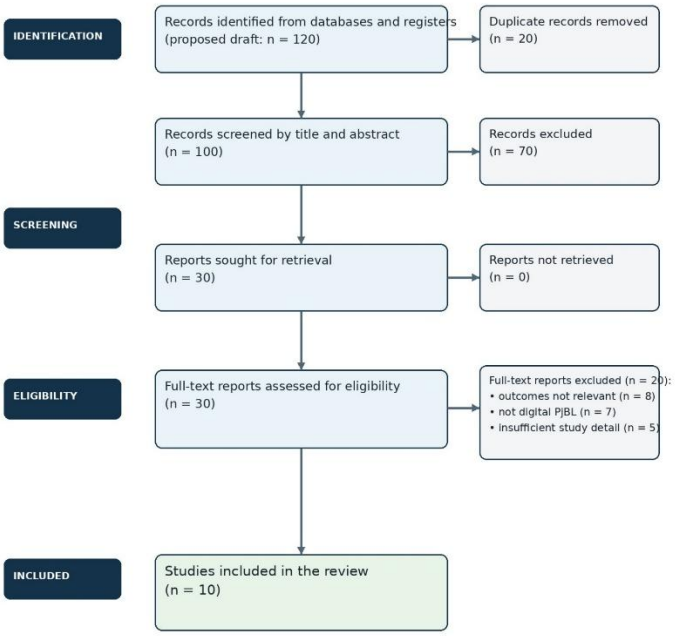

Figure 1. PRISMA 2020 Flow Diagram

RESULTS AND DISCUSSION

Result

Overview of the Evidence

The available literature supports three broad findings. First, digital tools can support collaboration and product development throughout project work, but their use is uneven across project phases. Second, reviews and meta-analyses generally report positive learning effects from PjBL, although outcomes depend on implementation and study context. Third, learner autonomy is a plausible outcome of project work, but it is less consistently measured than achievement and affective outcomes. Hinostroza et al. (2025) reviewed 24 technology-integrated PjBL interventions in K–12 settings. Initiation and execution activities appeared in all reviewed studies, planning activities in 88%, and closing activities such as product review and reflection in only 46%. The review also identified nine functions for digital tools, including organizing and sharing information, accessing learning content, collecting data, designing and producing project products, and presenting results. These findings suggest that digital environments often support project creation, while reflection and project closure receive less consistent attention. Evidence on learning outcomes is favorable but broad. Chen and Yang's (2019) meta-analysis reported an overall advantage for PjBL in academic achievement, with variation across study conditions. Zhang and Ma (2023) analyzed 66 experimental or quasi-experimental papers, producing 190 effect estimates, and reported positive effects on learning outcomes, including achievement, affective outcomes, and thinking skills. Their analysis also identified moderators such as subject area, group size, class size, and intervention duration. These meta-analytic findings support PjBL's potential but do not establish a single effect size specifically for digital PjBL, collaboration, creativity, or autonomy.

Table 1. Evidence Matrix

Evidence source	Scope or reported data	Findings relevant to this review
Hinostroza et al. (2025)	24 technology-integrated K–12 PjBL interventions	Initiation and execution were reported in all studies; planning in 88%; closing in 46%. Digital tools supported information sharing, research, design, production, and presentation.
Chen and Yang (2019)	Meta-analysis of PjBL and academic achievement	Overall achievement favored PjBL, with effects varying across study conditions. The analysis was not limited to digital implementations.
Zhang and Ma (2023)	66 experimental/quasi-experimental papers; 190 effect estimates	Positive effects were reported for achievement, affective outcomes, and thinking skills; effects varied by contextual and instructional moderators.
Guo et al. (2020)	Review of empirical PjBL studies in higher education	Affective outcomes and self-report measures were common. Product performance and learning processes were less consistently assessed.
Gündoğdu and Merç (2022)	Review of technology-supported collaborative creativity	Web-based tools were a favored technology form; the reviewed literature described teacher-, student-, and technology-related challenges, alongside collaborative problem solving.
Markula and Aksela (2022)	Multiple-case study of K–12 science PjBL implementation	The study examined how teachers enact core PjBL characteristics, highlighting implementation as an important context for interpreting outcomes.
Kokotsaki et al. (2016)	Review of PjBL literature	Student autonomy, inquiry, goal-setting, collaboration, communication, and reflection are central features of PjBL.
Online PjBL autonomy study, Indonesian EFL context	Student accounts of online project work	The report describes autonomy alongside challenges including motivation, discipline, time management, interaction, and dependence on lecturer direction.
Digital creativity review	Review of digital technology products and student creativity	Identified digital product categories and ways technology may influence creativity, including motivation, higher-order thinking, and creative cooperation.
Broader PjBL empirical literature	Studies across subjects and education levels	Outcomes and assessment approaches vary, limiting direct comparison across settings and reinforcing the need to report project design and measures clearly.

Findings by Outcome

Collaboration. Digital platforms can support sharing, feedback, task coordination, and joint product development. The technology-supported collaborative creativity review also indicates that implementation challenges may be addressed through group problem solving and attention to team relationships. However, evidence of tool use alone does not demonstrate equal participation or effective teamwork; these outcomes require direct assessment. Creativity. PjBL provides opportunities for students to generate and refine ideas through authentic tasks and tangible products. Digital tools can support creative production and cooperation, while meta-analytic research reports broader positive effects on thinking outcomes. Yet the cited evidence does not provide a pooled estimate for creativity specifically within digital PjBL. Creativity should therefore be reported through the measures used in each included study rather than inferred from achievement gains. Learner autonomy. Project planning, independent inquiry, role decisions, and progress monitoring create opportunities for learners to take responsibility. At the same time, online project work can involve challenges with motivation, time management, discipline, interaction, and reliance on instructor guidance. The current evidence therefore suggests that autonomy is supported by structured choice and scaffolding, rather than by digital delivery alone.

Synthesis

Across the available evidence, digital PjBL appears most consistently associated with collaborative project activity and the development of products. Evidence for creativity and learner autonomy is promising but less directly comparable because studies differ in definitions, measures, educational settings, and digital tools. The gap between frequent project execution and less frequent project closure also suggests that reflection, revision, and self-assessment deserve greater attention. For the final manuscript, these findings should be replaced or confirmed using the actual 10 included articles, with their study designs, participant

data, instruments, and reported results. The evidence matrix and aggregate counts above must not be presented as the results of those 10 articles unless they match the completed extraction.

Discussion

Digital Project Design and Learning Processes

A central finding concerns the uneven implementation of project phases. In Hinostroza et al.'s (2025) review of 24 technology-integrated K–12 interventions, initiation and execution activities appeared in all studies, planning in 88%, and closing activities in only 46%. This pattern suggests that many interventions are organized around launching and producing a project, while fewer explicitly document final review, revision, and reflection. Such imbalance matters because students may complete a digital product without having a structured opportunity to examine the quality of their work, explain what they learned, or evaluate how the team functioned. The functions assigned to digital tools also help explain the pattern. Across the reviewed interventions, technology supported information organization and sharing, access to content, data collection, product design and production, and presentation (Hinostroza et al., 2025). These uses give learners practical ways to enact project work, yet they do not guarantee that technology is integrated with the learning objectives. A platform may facilitate communication while leaving roles, participation, and feedback poorly structured. Therefore, digital PjBL should be interpreted as a pedagogical design in which technology supports learning processes, rather than as conventional project work simply moved online.

Collaboration as a Structured Outcome

The literature indicates that collaboration is both a core feature of PjBL and an outcome that requires deliberate support. Digital environments allow students to share drafts, coordinate tasks, and exchange feedback across time and place. Gündoğdu and Merç's (2022) review of 21 studies on technology-supported collaborative creativity identified technology as a tool, a medium for co-creation, or a tutor guiding parts of the creative process. In a related review of 26 empirical studies in language education, digital technologies most often functioned as tools or media for collaborative creativity; audio and video platforms were among the most frequently used forms (Shadiev et al., 2022). Together, these reviews suggest that tools can create conditions for collaboration, but the learning value comes from the activity students perform with them. Empirical findings reinforce the importance of group processes. In an interdisciplinary project-based graduate course involving 3,300 students, Johnsen et al. (2024) reported significant improvement in students' interdisciplinary, interpersonal, and conflict-management skills from the beginning to the end of the course ($p < .001$, $d > 0.4$). Outcomes also varied by student group, underscoring that collaboration cannot be reduced to individual characteristics alone. Similarly, Dincă et al. (2023) described virtual team development through stages of team-building, teamwork, and team performance. These findings point to a need for clear roles, communication routines, and feedback practices in digital project work. Without them, unequal participation or unresolved conflict can limit the collaborative potential of PjBL.

Creativity and Digital Production

Creativity is a prominent expected outcome of PjBL because students must generate ideas and translate them into an artifact, solution, or presentation. Digital tools can expand the range of products students can create and the ways in which they can share and revise them. Tang et al. (2022), in a review of digital technology products and student creativity, identified six categories of products and highlighted possible pathways such as motivation, higher-order thinking, creative cooperation, and professional activity. Shadiev et al. (2022) likewise found that digital tools could support co-creative activity as an instrument for thinking, a collaborative medium, or a guide to creative processes. More direct empirical evidence comes from Shadiev et al. (2022), who studied a telecollaborative project using 360-degree video with 15 junior high school students in China and 10 university students in Indonesia. Participants created cultural learning content, shared it with international partners, and exchanged comments to improve the products. The authors reported improved creativity, innovation, and entrepreneurship outcomes, alongside positive perceptions of the learning experience. While this small study cannot establish general effects across educational contexts, it illustrates how authentic audiences, multimodal production, and peer feedback can connect digital project work with creative development. Meta-analytic findings also require careful interpretation. Kwon and Lee's (2025) analysis of eight STEM PjBL studies, comprising 13 effect sizes, reported a substantial pooled effect on creativity (ES = 3.888, 95% CI [3.609, 4.166]), but also considerable heterogeneity (I^2 = 65%). Because the estimate is based on a small number of studies and the included contexts may differ, it should be read as evidence of potential rather

than a universal expected effect. In addition, Wang et al. (2024) reported a moderately positive effect of virtual technology on creativity (ES = 0.596), with outcomes differing across learner levels and instructional approaches. This broader digital-technology result is relevant context, but it should not be interpreted as an effect estimate for digital PjBL specifically.

Learner Autonomy and Instructor Scaffolding

Learner autonomy is fostered when students make decisions, plan tasks, locate information, monitor progress, and take responsibility for completing a project. Online environments can support this process by offering flexible access to resources and allowing learners to work independently. In a mixed-methods study involving 80 students at a public university in Surabaya, Chakim et al. (2026) reported high autonomy across technical, psychological, political, and sociocultural dimensions. Students described flexibility and internet access as helpful, while also identifying low motivation, poor time management, limited interaction, dependence on lecturers, and required instructions as challenges. This combination suggests that autonomy is not simply independence from the instructor; it involves having meaningful choices and sufficient support to manage learning. These findings help explain why digital PjBL should balance learner agency with teacher scaffolding. Excessive direction can reduce students' control over project decisions, while insufficient guidance can leave teams unsure how to define tasks, evaluate information, or resolve difficulties. Guo et al. (2020) found that higher-education PjBL studies often measured affective outcomes using self-report tools, while product performance and learning processes were less consistently assessed. Consequently, claims about autonomy should be supported by more than students' general satisfaction: studies should document self-management behaviors, decision-making, and reflection alongside perceptions.

Integrating the Three Outcomes

Taken together, the evidence suggests that collaboration, creativity, and autonomy are interconnected but should not be treated as interchangeable. Students may collaborate without creating original products, and a creative outcome may still depend heavily on instructor direction. Strong digital PjBL therefore needs coordinated design: teams work on authentic questions; students share responsibility and receive feedback; digital tools support inquiry and production; and project closure includes revision and individual or group reflection. These conditions are consistent with the phase-related findings of Hinostroza et al. (2025) and with broader evidence that PjBL outcomes vary according to implementation and context (Chen & Yang, 2019; Zhang & Ma, 2023). The meta-analyses by Chen and Yang (2019) and Zhang and Ma (2023) report generally favorable learning effects for PjBL, while also identifying variation by subject and instructional conditions. Such findings provide a useful empirical foundation, but they do not establish that digital PjBL always improves each of the three focal outcomes. A recent computational-thinking meta-analysis similarly associated PjBL with improvements across several higher-order skills, including creativity, collaboration, and problem solving, although that evidence is specific to computational-thinking contexts (Zhang et al., 2024). The review should therefore distinguish direct findings about digital PjBL from broader findings about PjBL or educational technology.

Limitations and Implications

The evidence base remains heterogeneous in educational level, discipline, digital format, project duration, and outcome measurement. Some studies focus on achievement or engagement, while others assess creative products, collaboration, or learner autonomy. Reviews may also include overlapping primary studies, so their sample totals should not be added together as if they represented unique articles. This limits the precision of comparisons and prevents a single pooled estimate for collaboration, creativity, and autonomy in digital PjBL. For future research, studies should describe project phases and digital-tool functions in sufficient detail, measure each focal outcome with appropriate instruments, and report both product quality and learning processes. Particular attention should be given to reflection and revision, which were less commonly documented in the reviewed K–12 interventions. For practice, digital PjBL should combine student choice with clear milestones, collaborative roles, actionable feedback, and structured reflection. Overall, the literature supports digital PjBL as a promising approach whose contribution depends on coherent project design, active collaboration, opportunities for creative production, and scaffolding that enables students to manage their learning.

CONCLUSION

Digital project-based learning (PjBL) can support collaboration, creativity, and learner autonomy when technology is integrated into inquiry, shared production, feedback, and reflection. Across 24

technology-integrated K–12 interventions, initiation and execution appeared in all studies, planning in 88%, and closing activities in 46%, indicating that reflection was less consistently implemented (Hinostroza et al., 2025). A meta-analysis of 66 experimental and quasi-experimental papers, comprising 190 effect estimates, reported positive effects on achievement, affective outcomes, and thinking skills, with variation by context (Zhang & Ma, 2023). A STEM PjBL meta-analysis of eight studies and 13 effect sizes found a substantial creativity effect (ES = 3.888, 95% CI [3.609, 4.166]), alongside considerable heterogeneity (I^2 = 65%) (Kwon & Lee, 2025). In an Indonesian online PjBL study of 80 university students, autonomy was high across four dimensions, while low motivation, weak time management, limited interaction, and lecturer dependence remained challenges (Chakim et al., 2026). Overall, digital PjBL is promising but context-dependent. Effective implementation requires balanced scaffolding, meaningful learner choice, clear team roles, iterative feedback, and time for reflection. These figures come from different reviews and populations; they do not represent one shared sample. The final manuscript should report results from its ten included primary studies separately and use outcome-specific measures of collaboration, creativity, and autonomy.

REFERENCES

Chakim, N., Widiati, U., Prayogo, J. A., & Romadhon, A. S. (2026). Learner autonomy in an online project-based learning: Voices from Indonesian EFL students. JEES (Journal of English Educators Society), 11(1), 1–12. https://doi.org/10.21070/jees.v11i1.1959

Chen, C.-H., & Yang, Y.-C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. Educational Research Review, 26, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001

Dincă, M., Luştrea, A., Craşovan, M., Onițiu, A., & Berge, T. (2023). Students' perspectives on team dynamics in project-based virtual learning. SAGE Open, 13(1). https://doi.org/10.1177/21582440221147269

Gündoğdu, B., & Merç, A. (2022). A systematic review of tech-supported collaborative creativity practices in the field of education. Journal of Learning and Teaching in Digital Age, 7(1), 76–89. https://doi.org/10.53850/joltida.953760

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. International Journal of Educational Research, 102, Article 101586. https://doi.org/10.1016/j.ijer.2020.101586

Hinostroza, J. E., Armstrong-Gallegos, S., Soto-Valenzuela, P., & Villafaena, M. (2025). Phases and activities of technology-integrated project-based learning in K-12: Findings from a systematic literature review. Education Sciences, 15(8), Article 1021. https://doi.org/10.3390/educsci15081021

Johnsen, M. M. W., Sjølie, E., & Johansen, V. (2024). Learning to collaborate in a project-based graduate course: A multilevel study of student outcomes. Research in Higher Education, 65, 1–24. https://doi.org/10.1007/s11162-023-09754-7

Khaerudin, et al. (2026). Designing a project-based learning model with digital technology integration to enhance students' creativity in craft subject. Teknodika. https://jurnal.uns.ac.id/Teknodika/article/view/110789

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733

Kwon, H., & Lee, Y. (2025). A meta-analysis of STEM project-based learning on creativity. STEM Education, 5(2), 275–290. https://doi.org/10.3934/steme.2025014

Learner autonomy in an online project-based learning: Voices from Indonesian EFL students. (n.d.). Journal of English Educators Society. https://jees.umsida.ac.id/index.php/jees/article/view/1959

Lu, S.-Y., Lo, C.-C., & Syu, J.-Y. (2022). Project-based learning oriented STEAM: The case of micro:bit paper-cutting lamp. International Journal of Technology and Design Education, 32(5), 2553–2575. https://doi.org/10.1007/s10798-021-09714-1

Markula, A., & Aksela, M. (2022). The key characteristics of project-based learning: How teachers implement projects in K-12 science education. Disciplinary and Interdisciplinary Science Education Research, 4, Article 2. https://doi.org/10.1186/s43031-021-00042-x

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. PLOS Medicine, 18(3), Article e1003583. https://doi.org/10.1371/journal.pmed.1003583

Selfa-Sastre, M., Pifarré, M., Cujba, A., Cutillas, L., & Falguera, E. (2022). The role of digital technologies to promote collaborative creativity in language education. Frontiers in Psychology, 13, Article 828981. https://doi.org/10.3389/fpsyg.2022.828981

Shadiev, R., Yi, S., Dang, C., & Sintawati, W. (2022). Facilitating students' creativity, innovation, and entrepreneurship in a telecollaborative project. Frontiers in Psychology, 13, Article 887620. https://doi.org/10.3389/fpsyg.2022.887620

Shadiev, R., et al. (2022). The role of digital technologies to promote collaborative creativity in language education. Frontiers in Psychology, 13, Article 828981. https://doi.org/10.3389/fpsyg.2022.828981

Siddaway, A. P., Wood, A. M., & Hedges, L. V. (2019). How to do a systematic review: A best practice guide for conducting and reporting narrative reviews, meta-analyses, and meta-syntheses. Annual Review of Psychology, 70, 747–770. https://doi.org/10.1146/annurev-psych-010418-102803

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. Journal of Business Research, 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Tang, C., Mao, S., Naumann, S. E., & Xing, Z. (2022). Improving student creativity through digital technology products: A literature review. Thinking Skills and Creativity, 44, Article 101032. https://doi.org/10.1016/j.tsc.2022.101032

Wang, Y., Liu, W., Yu, X., Li, B., & Wang, Q. (2024). The impact of virtual technology on students' creativity: A meta-analysis. Computers & Education, 215, Article 105044. https://doi.org/10.1016/j.compedu.2024.105044

Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. Journal of Planning Education and Research, 39(1), 93–112. https://doi.org/10.1177/0739456X17723971

Zen, Z., Reflianto, Syamsuar, & Ariani, F. (2022). Academic achievement: The effect of project-based online learning method and student engagement. Heliyon, 8(11), Article e11509. https://doi.org/10.1016/j.heliyon.2022.e11509

Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: A meta-analysis study. Frontiers in Psychology, 14, Article 1202728. https://doi.org/10.3389/fpsyg.2023.1202728

Zhang, W., Guan, Y., & Hu, Z. (2024). The efficacy of project-based learning in enhancing computational thinking among students: A meta-analysis of 31 experiments and quasi-experiments. Education and Information Technologies. https://doi.org/10.1007/s10639-023-12392-2