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A Conceptual Review of Studio-Based Learning for Developing 21st-Century Competencies in Vocational Education

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Abstract:
The transformation of the workplace driven by digitalization, automation, and industrial complexity requires vocational education to develop not only technical skills but also 21st-century competencies, including creativity, critical thinking, collaboration, communication, problem-solving, digital literacy, self-directed learning, and adaptability. Although studio-based learning has been widely studied in design and architecture education, its relevance as a vocational pedagogical framework for developing 21st-century competencies has yet to be articulated in a conceptually integrated manner. This article adopts a conceptual review approach to examine and articulate the relevance of studio-based learning to the development of 21st-century competencies in vocational education. The synthesis identifies studio-based learning as authentic, iterative, reflective, collaborative, critique-based, and oriented toward producing solutions. This approach is relevant to vocational education because it provides learning experiences that mirror professional practice through authentic projects, studio critiques, reflection, revision of work, teamwork, and technology use. The article proposes the Studio-Based Learning for Vocational 21st-Century Competence Development Framework, which explains how 21st-century competencies develop through the mechanisms of authentic problem engagement, iterative making, dialogic critique, collaborative learning, reflective professional learning, self-directed inquiry, and digital/hybrid studio mediation.

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Introduction (مقدمة)

The workplace continues to evolve as digital technologies and automation advance, requiring vocational education to equip graduates with both technical skills and 21st-century

competencies. According to Hassan et al. (2021), integrating information and communication technology (ICT) into vocational education is essential for developing a digitally skilled workforce, yet its current implementation remains inadequate. Vocational education also needs to align its educational systems with evolving industry needs and prepare students for dynamic work environments (Lewis, 2023). Accordingly, a comprehensive approach that combines technical and soft skills is essential for preparing the future workforce (Ilgaz, 2021).

Vocational education contributes to preparing individuals for employment but faces challenges, particularly in integrating 21st-century skills into its curricula. Current practices often prioritize technical procedures over problem-solving and collaboration, contributing to a disconnect between educational institutions and workplace demands (Bouw et al., 2021; Thornhill-Miller et al., 2023). Research indicates that effectively integrating theory and practice is essential for developing these competencies; however, many vocational education institutions continue to struggle with this integration (Orozco et al., 2019). Addressing these challenges requires learning environments that bridge the gap between school and work, providing more holistic educational experiences aligned with contemporary workforce needs (Bouw et al., 2021).

Studio-based learning is particularly well suited to vocational education because it reflects the complexity and dynamics of professional environments while developing essential skills through project-based learning. This approach emphasizes practice, exploration, and critical reflection, all of which are essential to developing professional competence. Collaborative projects can also prepare students for workplace challenges by engaging them with external partners and diverse stakeholders (Mcara & Ross, 2020). According to Nerland (2018), the evolving nature of professional expertise requires adaptive learning environments that accommodate specialized knowledge and practice. This perspective underscores the relevance of studio-based learning to vocational education.

Studio-based learning has been examined across various educational fields, particularly design, architecture, and project-based learning, because of its capacity to enhance creativity, problem-solving, collaboration, and reflection. Soomro et al. (2023) examined makerspaces as a form of studio-based learning and reported enhanced creativity in STEM education through hands-on learning environments that encourage innovative thinking and problem-solving. In architecture, the design studio is a central component of education, where the design process is explored through user engagement and contextual understanding, although gaps remain in integrating user perspectives throughout the design process (Hettithanthri et al., 2021, 2022). In STEAM education, project-based learning (PBL) strategies combined with a cognitive–affective interaction model have been shown to improve students' creativity and performance, aligning with the emphasis of studio-based learning on innovative thinking (Hsiao et al., 2022). Huang et al. (2023) also reported that gamified project-based learning effectively enhances student motivation and learning outcomes, consistent with the integration of innovative and creative methods into studio-based learning. Overall, studio-based learning represents an effective approach to developing essential skills and competencies across disciplines.

The novelty of this article lies in conceptualizing studio-based learning as a vocational pedagogical approach that integrates practical experience, reflective critique, collaboration, the production of work, and authentic problem-solving as mechanisms for developing 21st-century competencies. Unlike studies that position the studio solely as a physical space or a method specific to design education, this article conceptualizes studio-based learning as a learning ecology with broader applicability to vocational education. This argument rests on the premise that vocational education requires approaches that enable students to develop knowledge through action, dialogue, experimentation, and reflection on the quality of the products or solutions they create. From this perspective, studio critique can be understood as a mechanism for strengthening critical thinking and communication, project work for enhancing creativity and

problem-solving, studio collaboration for developing teamwork, and the revision of work for strengthening self-regulation and adaptability. The conceptual contribution of this article is therefore to extend studio-based learning beyond design pedagogy into a vocational pedagogical framework for developing 21st-century competencies in a more integrated manner.

Against this background, this article aims to examine and articulate the relevance of studio-based learning to the development of 21st-century competencies in vocational education through a conceptual review that synthesizes literature on studio pedagogy, vocational pedagogy, experiential learning, and future competencies. Specifically, it seeks to explain the key characteristics of studio-based learning, identify its alignment with the principles of vocational education, and articulate the pedagogical mechanisms linking studio activities to the development of creativity, critical thinking, collaboration, communication, problem-solving, digital literacy, and adaptability. Adopting a conceptual review approach, this article seeks to establish a theoretical foundation for curriculum development, instructional design, and subsequent empirical research in vocational education rather than empirically test the effectiveness of studio-based learning. It is therefore expected to contribute theoretically to the development of vocational pedagogy and practically to the work of faculty members, vocational program administrators, and curriculum designers seeking to prepare graduates to meet the demands of the 21st-century workplace.

Method (منهج)

Research Design

This study adopted a conceptual review design using an integrative literature review approach. This design was selected to align with the study's objective of analyzing, integrating, and developing conceptual arguments regarding the relevance of studio-based learning to the development of 21st-century competencies in vocational education. The integrative literature review approach was intended to facilitate the identification of conceptual patterns, relationships among constructs, and theoretical gaps that could inform the development of a new conceptual framework.

Focus and Scope of the Review

The review focused on the relevance of studio-based learning to the development of 21st-century competencies in vocational education. Its scope encompassed vocational higher education, polytechnics, and practice-based learning programs oriented toward work readiness and professional competence.

Data Sources and Literature Search Strategy

The data sources consisted of scholarly journal articles addressing studio-based learning, vocational education, and the development of 21st-century competencies. Literature searches were conducted in the Scopus and ERIC databases. The main search terms included "studio-based learning", "vocational education", "vocational pedagogy", and "twenty-first century skills." The search and review process proceeded through successive stages of title and abstract screening, full-text reading, assessment of conceptual relevance, and extraction of key information.

Literature Inclusion and Exclusion Criteria

Literature was selected using inclusion and exclusion criteria to ensure its relevance to the review's objectives. Studies were included if they addressed studio-based learning in vocational higher education, polytechnics, or practice-based learning programs oriented toward work readiness and professional competence. Eligible studies also addressed the development of 21st-

century competencies, particularly creativity, critical thinking, collaboration, communication, problem-solving, digital literacy, self-regulation, and adaptability. Studies were excluded if they were unrelated to studio-based learning, focused on general education, or did not address 21st-century competencies or work readiness. Documents were also excluded if their full texts were unavailable, their academic provenance was unclear, or they consisted solely of opinion without conceptual and empirical support.

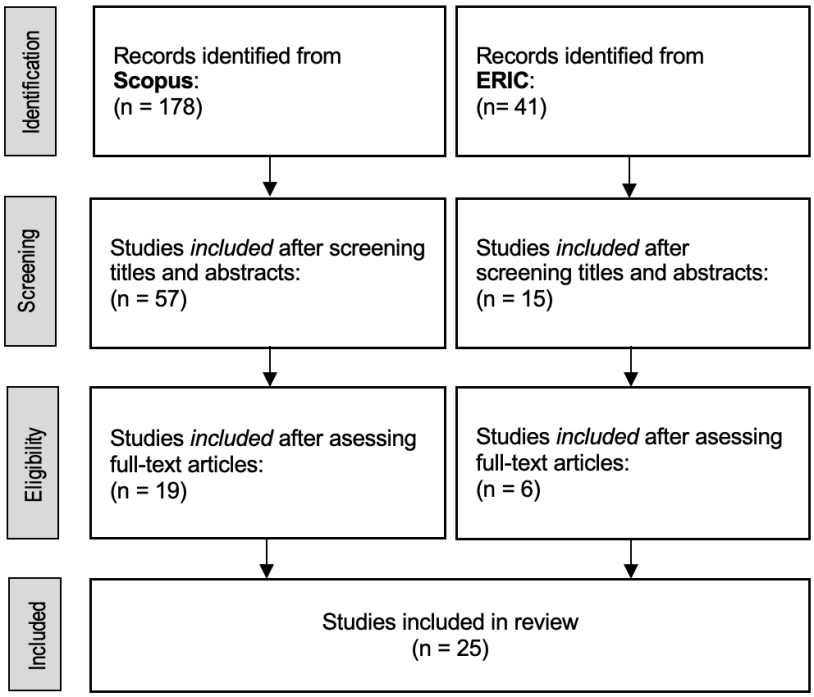

Figure 1. Study Selection Flow Chart

Data Analysis Procedures

Data were analyzed using content analysis and thematic analysis. Content analysis was used to identify the concepts, definitions, learning principles, and key characteristics of studio-based learning and their connections to vocational education. Thematic analysis was used to organize findings from the literature into broader conceptual themes. The initial themes guiding the analysis included the characteristics of studio-based learning, learning principles in vocational education, types of 21st-century competencies, and implications of implementing studio-based learning in vocational education. These themes were subsequently compared, refined, and synthesized to develop a more coherent conceptual structure.

Conceptual Synthesis Framework

The synthesis framework connects three main domains: the characteristics of studio-based learning, learning principles in vocational education, and 21st-century competencies, as presented in Table 1.

Table 1. Conceptual Synthesis Framework

Conceptual Domain	Analytical Focus	Direction of Synthesis
Studio-based learning	Authentic projects, studio practice, critique, reflection, revision of work, and the production of solutions	Identify the pedagogical characteristics that distinguish studio-based learning from conventional instruction
Vocational education	Work readiness, technical skills, professional practice, performance-	Explain the alignment between studio-based learning and the competency orientation of vocational education

	based learning, and industry relevance	
21st-century competencies	Creativity, critical thinking, collaboration, communication, problem-solving, digital literacy, and adaptability	Articulate the relationship between studio-based learning and the development of 21st-century competencies
Integrative synthesis	Relationships among the studio approach, vocational education needs, and future competencies	Develop a conceptual framework explaining the relevance of studio-based learning to vocational education

Methodological Limitations

As a conceptual review, this article seeks to establish a conceptual foundation for understanding the relevance of studio-based learning to the development of 21st-century competencies in vocational education rather than statistically assess its effectiveness. The resulting conceptual framework requires empirical validation through further research, such as experimental studies, design and development research, or mixed-methods studies. Nevertheless, a key strength of this review lies in its integration of literature across the fields of studio-based learning, vocational education, and 21st-century competency development.

Result (نتائج)

Data extraction from 25 articles yielded 29 groups of findings, which were organized into seven overarching themes: (1) authentic learning experiences and professional alignment; (2) iteration, critique, and reflection; (3) design thinking, creativity, and problem-solving; (4) collaboration, communication, and peer learning; (5) technological mediation and hybrid studios; (6) self-directed learning and learner agency; and (7) enabling conditions and implementation challenges.

Thematic Distribution of the Synthesized Findings

The categorization revealed that authentic learning experiences and professional alignment, along with iteration, critique, and reflection, were the most frequently represented themes, each appearing in 18 articles. These were followed by enabling conditions and implementation challenges, which appeared in 16 articles, and collaboration, communication, and peer learning, which appeared in 14 articles. Design thinking, creativity, and problem-solving, along with technological mediation and hybrid studios, each appeared in 11 articles. Self-directed learning and learner agency was the least frequently represented theme, appearing in eight articles.

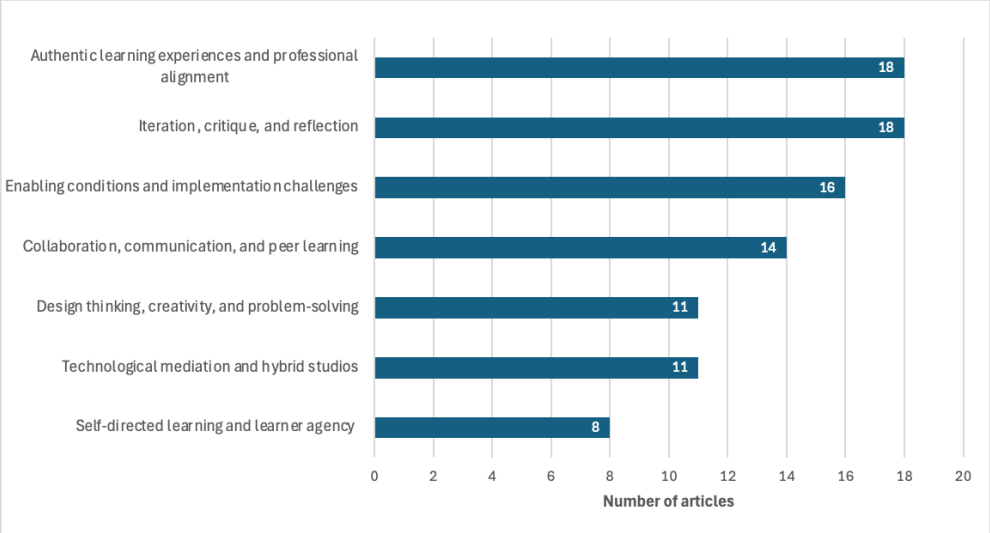

Figure 2. Thematic Distribution of Synthesized Findings on Studio-Based Learning in Vocational Education

Key Characteristics of Studio-Based Learning

The synthesis identified five key characteristics of studio-based learning. First, it is grounded in authentic projects and open-ended problems. Students are expected not only to understand concepts but also to address real-world problems, identify user needs, consider contextual constraints, and develop defensible solutions.

Second, studio-based learning is iterative. Learning does not proceed linearly from theory to a final assignment but unfolds through cycles of designing, making, testing, receiving critique, reflecting on weaknesses, revising, and improving work. Third, studio-based learning places critique and feedback at the center of learning. Studio critiques, peer feedback, formative assessment rubrics, and dialogue with instructors serve to clarify performance standards, broaden perspectives, and help students assess the quality of their decisions. Fourth, studio-based learning is collaborative. The studio serves not only as an individual workspace but also as a social environment where students learn through discussions, presentations of work, peer critiques, group work, and interactions with instructors, peers, users, communities, or professional partners. Fifth, studio-based learning is oriented toward producing work or solutions. Learning extends beyond conceptual understanding to the creation of artifacts, designs, prototypes, products, strategies, or solutions that can be presented, critiqued, and refined.

Relevance of Studio-Based Learning to Vocational Education

The synthesis indicates that studio-based learning aligns with the orientation of vocational education, which emphasizes practice-based learning, performance, work readiness, technical skills, industry relevance, and problem-solving. These priorities are consistent with studio-based learning, which engages students in learning situations that mirror professional practice, such as designing products, addressing real-world problems, presenting work, receiving critique, and making continuous improvements.

In vocational education, students need to develop the ability to make decisions in complex situations, and studio-based learning supports the development of this ability. Students learn to understand problems, weigh alternative solutions, incorporate feedback, test ideas, and justify the outcomes of their work. Studio-based learning thus develops technical skills while cultivating

professional ways of thinking.

Mechanisms for Developing 21st-Century Competencies

The synthesis indicates that studio-based learning contributes to the development of 21st-century competencies through several learning mechanisms. First, authentic problem engagement develops critical thinking and problem-solving because students must understand the context, identify constraints, analyze needs, and formulate appropriate solutions. Second, iterative making and improvement involves creating, testing, receiving critique, revising, and refining work. This mechanism develops creativity, adaptability, and the ability to learn from failure. Third, dialogic critique and feedback develops critical thinking by requiring students to justify their decisions, assess the strengths and weaknesses of their work, and consider others' perspectives. Fourth, collaborative knowledge construction develops collaboration, communication, negotiation skills, and awareness of different perspectives. Fifth, reflective professional learning strengthens self-directed learning, self-regulation, and readiness for lifelong learning. Sixth, digital and hybrid studio mediation refers to the role of technology in extending the studio through collaborative platforms, process documentation, online feedback, open educational resources, and communication across locations.

Table 2. Mapping Studio-Based Learning Mechanisms to 21st-Century Competencies

Pedagogical Mechanism	Studio Activities	21st-Century Competencies Developed
Authentic problem engagement	Real-world projects, open-ended problems, user contexts, community needs, and professional situations	Critical thinking, problem-solving, and professional readiness
Iterative making and improvement	Prototyping, revision of work, solution testing, and iterative improvement	Creativity, adaptability, perseverance, and problem-solving
Dialogic critique and feedback	Studio critiques, peer feedback, formative assessment rubrics, and discussions with instructors	Critical thinking, communication, and reflection
Collaborative knowledge construction	Teamwork, group discussions, peer learning, and joint presentations	Collaboration, communication, negotiation, and empathy
Reflective professional learning	Reflective journals, portfolios, process evaluation, and self-assessment	Self-directed learning, self-regulation, and lifelong learning
Digital and hybrid studio mediation	Collaborative platforms, open educational resources (OER), online critiques, learning management systems (LMS), Miro, Padlet, Zoom, Moodle, and digital documentation	Digital literacy, digital collaboration, and learning flexibility

Variations and Contradictions in the Findings

The synthesis indicates that studio-based learning is highly relevant to vocational education, although several variations and contradictions warrant consideration. First, open-ended problems in the studio can develop creativity and problem-solving but may also cause confusion when students lack adequate initial guidance. Second, although studio-based learning encourages self-directed learning, students still require a structured learning environment. The findings indicate that learner agency develops when students have opportunities to make

decisions while receiving instructional scaffolding through initial orientation, examples, assessment rubrics, and formative feedback.

Third, technology can extend the studio environment but does not automatically replace the physical studio. Some studies indicate that technology supports documentation, collaboration, scheduling flexibility, and feedback. Others, however, suggest that spontaneous interactions, hands-on work with materials, the studio atmosphere, and a sense of community remain difficult to replicate fully online. Fourth, rubrics and formative assessment can clarify learning expectations but risk becoming mechanical when used solely for administrative purposes. In studio-based learning, assessment needs to be embedded in a dialogic and reflective process. Fifth, large-scale implementation of studio-based learning requires adequate infrastructure and well-developed management practices. Challenges include instructor and student workloads, limited facilities, unequal access to technology, coordination of teaching assistants, communication among group members, and the additional time required for revision.

Proposed Conceptual Framework

Based on the synthesis, this article proposes the Studio-Based Learning for Vocational 21st-Century Competence Development Framework. The framework explains the relevance of studio-based learning to vocational education through the relationships among (1) studio pedagogical characteristics, (2) alignment with vocational education principles, (3) mechanisms for competency development, (4) the 21st-century competencies developed, and (5) conditions supporting implementation.

The pedagogical characteristics of studio-based learning include real-world projects, studio practice, critique, reflection, revision of work, the production of solutions, and connections to professional practice. Its alignment with vocational education lies in its emphasis on performance-based learning, professional practice, technical skills, work readiness, and industry relevance. The mechanisms for competency development include authentic problem engagement, iterative making, dialogic critique, collaborative learning, reflective learning, self-directed inquiry, and digital/hybrid mediation. These mechanisms connect studio activities to the development of 21st-century competencies. The competencies developed include creativity, critical thinking, communication, collaboration, problem-solving, digital literacy, self-directed learning, adaptability, and professional readiness. The conditions supporting implementation encompass scaffolding, feedback quality, reflective rubrics, instructor competence, studio facilities, technology access, time management, a collaborative culture, and connections with industry, users, or communities, all of which influence the effectiveness of studio-based learning.

Conceptual Propositions

Based on the patterns identified in the findings and the resulting conceptual framework, this article formulates six conceptual propositions. These propositions are theoretical statements intended to guide further research on studio-based learning in vocational education and do not represent empirically tested findings.

Table 3. Conceptual Propositions on Studio-Based Learning for Developing 21st-Century Competencies in Vocational Education

Code	Conceptual Proposition
P1	The greater the authenticity of studio-based learning, the greater the opportunities for students to develop critical thinking, problem-solving, and professional readiness.
P2	Iterative processes of critique, reflection, and revision serve as key mechanisms linking studio activities to the development of creativity and adaptability.
P3	Social interactions in the studio through teamwork, presentations of work, peer critiques, and

Code	Conceptual Proposition
	feedback contribute to the development of communication and collaboration.
P4	Self-directed learning in the studio develops when students have opportunities to make decisions while receiving scaffolding within a clearly structured pedagogical framework.
P5	Technology strengthens studio-based learning when used to support collaboration, process documentation, feedback, and access to learning resources rather than to replace the physical studio.
P6	The effectiveness of studio-based learning in vocational education depends on enabling conditions, including instructor competence, task design, studio facilities, assessment rubrics, time, and connections to professional contexts.

Overall, the findings indicate that studio-based learning is a relevant pedagogical approach to vocational education because it can integrate authentic experiences, professional practice, iteration, critique, reflection, collaboration, and technology use.

Discussion (مناقشة)

Relevance of Studio-Based Learning to Vocational Education

The review indicates that studio-based learning is conceptually relevant to vocational education because its defining characteristics emphasize practice, the production of work, real-world problem-solving, critique, reflection, and iterative improvement. Brocato (2009) argues that the strength of studio-based learning lies in the processes of proposing, critiquing, and iterating, through which students construct understanding through action, feedback, and revision. This pattern is particularly relevant because vocational learning aims not only to transfer knowledge but also to develop the ability to act competently in complex, context-dependent work situations that require professional judgment (Billett, 2001; Ceelen et al., 2023).

Vocational education requires students not only to understand concepts but also to apply knowledge through products, services, designs, solutions, or work performance that can be observed and assessed (Billett, 2001; McArthur, 2023). Studio-based learning provides a learning environment that addresses these needs through authentic projects, challenging problem situations, presentations of work, peer critiques, dialogue with instructors, and continuous product revision (Brandt et al., 2013; Cennamo et al., 2011).

The review also indicates that studio principles extend beyond design and can be repositioned as an approach to vocational learning across disciplines because their pedagogical core centers on authentic practice, professional reflection, collaboration, and the production of solutions (Brandt et al., 2013; Cennamo & Brandt, 2012). In vocational education, students need regular opportunities to address problems that are not always well structured, do not necessarily have a single correct answer, and require balancing theory, technical skills, user needs, professional standards, and resource constraints (Cennamo et al., 2011; Kumar et al., 2021). Thus, in response to the first research question, studio-based learning is relevant to vocational education because it mirrors an ecosystem of professional practice rather than merely representing a variation of project-based learning.

Contributions of Studio-Based Learning to 21st-Century Competencies

The review indicates that studio-based learning contributes to the development of 21st-century competencies, particularly creativity, critical thinking, communication, collaboration, problem-solving, digital literacy, self-directed learning, adaptability, and professional readiness. This finding aligns with the literature on 21st-century competencies, which identifies creativity, critical thinking, communication, and collaboration as core competencies for responding to

changes in society, technology, and the workplace (Thornhill-Miller et al., 2023; Voogt & Roblin, 2012). In studio-based learning, these competencies are developed through generating ideas, testing solutions, receiving critique, communicating, working in teams, and iteratively refining work (Brocato, 2009; Cennamo et al., 2011).

Creativity in studio-based learning is developed through exploring alternative solutions, developing prototypes, testing ideas, and revising work based on feedback. Cennamo et al. (2011) argue that studio learning is well suited to complex design problems because students are required to generate and refine solutions iteratively. Kumar et al. (2021) also report that students perceive studio-based learning as an experience that helps them improve their design, communication, and teamwork skills, as well as their receptiveness to critique.

Critical thinking and problem-solving develop because studio-based learning engages students with open-ended and ill-structured problems. Studio problems are addressed through problem framing, contextual analysis, identification of constraints, evaluation of alternatives, and reasoned decision-making rather than the application of a single formula (Cennamo et al., 2011; Cennamo & Brandt, 2012). Studio critique strengthens critical thinking by requiring students to explain design decisions, respond to questions, defend arguments, and reassess the quality of their solutions (Brocato, 2009). Accordingly, in response to the second research question, studio-based learning supports the development of 21st-century competencies because studio activities require students to think, make, engage in dialogue, reflect, and continuously improve their performance.

Collaboration and communication are also prominent competencies developed through studio-based learning. The studio serves as a social environment where students learn through discussions, presentations of work, peer critiques, teamwork, and the negotiation of ideas (Brandt et al., 2013; Cennamo & Brandt, 2012). Brown et al. (2015) show that studio practices can be extended to large classes through blended learning designs that incorporate collaborative technologies, while McLachlan & Tippett (2024) demonstrate that authentic feedback in online digital media learning can be designed to mirror cycles of creative collaboration in the workplace.

Self-directed learning and adaptability develop when students are given responsibility for planning their work processes, finding learning resources, selecting strategies, managing time, and making decisions about the products they develop. Studio-based learning encourages learner agency by guiding students to determine the direction of their ideas and develop their own strategies for addressing problems (Ryan et al., 2025; Sopher et al., 2025). However, students may also experience difficulties understanding studio expectations, managing tasks, and responding to critique (Kumar et al., 2021). Studio-based learning therefore needs to be designed as a student-centered approach with clear structure, scaffolding, rubrics, and formative feedback.

Digital literacy in studio-based learning develops when studio activities are extended through collaborative platforms, open educational resources, digital documentation, online critiques, and hybrid or flipped studio models. Chan et al. (2023) show that open educational resources in a studio-based flipped classroom can enrich video production learning experiences by combining independent learning, studio activities, and reflection. Brown et al. (2015) also demonstrate that blended practices enable studio approaches to be implemented in large classes with technological support. However, technology in studio-based learning is intended to extend the learning ecosystem by supporting collaboration, process documentation, access to resources, and feedback rather than to replace the physical studio (Fleischmann, 2014; Srirangam & Ng, 2022).

Pedagogical Mechanisms Linking Studio-Based Learning to 21st-Century Competencies

The main contribution of this review lies in explaining the pedagogical mechanisms that connect studio-based learning to the development of 21st-century competencies. This relationship operates through authentic, iterative, dialogic, reflective, collaborative, self-directed, and digitally supported learning processes (Brandt et al., 2013; Brocato, 2009; Cennamo et al., 2011).

The first mechanism is authentic problem engagement, through which students encounter real-world, open-ended, context-dependent problems closely connected to professional practice (Cennamo et al., 2011; McArthur, 2023). This engagement encourages students to understand the context, identify needs, assess constraints, and formulate defensible solutions. In vocational education, engagement with authentic problems is important because professional competence develops through experience with work situations that cannot be fully reduced to procedural exercises (Billett, 2001; Ceelen et al., 2023).

The second mechanism is iterative making and improvement, through which competencies develop across cycles of creating, testing, receiving critique, revising, and refining work (Brocato, 2009; Ryan et al., 2025). This mechanism contributes to creativity, adaptability, problem-solving, and self-regulation (Thornhill-Miller et al., 2023).

The third mechanism is dialogic critique and feedback, in which studio critique provides a dialogic space for examining reasoning, considering alternative perspectives, and improving the quality of decisions (Cennamo & Brandt, 2012; Sopher et al., 2025). McLachlan & Tippett (2024) argue that authentic feedback can be central to creative collaboration, particularly when students have opportunities to present work in progress and refine it in response to feedback. Studio critique therefore serves as an important mechanism for developing critical thinking, professional communication, and reflective abilities.

The fourth mechanism is collaborative knowledge construction. Knowledge in studio-based learning is constructed not only through instructor guidance but also through social interaction, peer learning, group discussions, peer critiques, and presentations of work (Brandt et al., 2013; Cennamo & Brandt, 2012). Brown et al. (2015) show that collaborative technologies can help extend studio practices to large classes, while Kumar et al. (2021) report that students perceive studio learning as beneficial for developing communication skills and receptiveness to teamwork.

The fifth mechanism is reflective professional learning, through which reflection helps students understand their decisions, strategies, work processes, and competency development (Cennamo et al., 2011; Ryan et al., 2025). Through reflection, students learn to assess the strengths and weaknesses of their own performance, thereby strengthening self-directed learning and readiness for lifelong learning.

The sixth mechanism is digital and hybrid studio mediation, through which technology can extend the studio environment by supporting process documentation, online collaboration, digital feedback, open educational resources, and interaction across locations (Brown et al., 2015; Chan et al., 2023). Fleischmann (2014) argues that Web 2.0 technologies can support studio collaboration but cannot fully replace the physical studio. Accordingly, blended, hybrid, flipped, and networked studio models are conceptually better suited to this approach than fully online models that entirely replace the physical studio.

Positioning the Findings Within the Existing Literature

The findings reinforce the literature that characterizes studio-based learning as an approach centered on practice, critique, dialogue, reflection, and iteration. Brocato (2009) identifies the process of proposing, critiquing, and iterating as a defining feature of studio-based learning, while Cennamo et al. (2011) position studio learning within problem-based learning as an

approach suited to complex design problems. Brandt et al. (2013) broaden this perspective through a studio ecology framework that conceptualizes the studio as a learning environment integrating space, practice, academic culture, and design epistemology.

This review also extends the existing literature by positioning studio-based learning as vocational pedagogy rather than solely as design pedagogy. Most studies of studio-based learning originate in design, architecture, media, and other creative fields (Brandt et al., 2013; Kumar et al., 2021). However, the synthesis indicates that studio principles, including authentic projects, critique, reflection, collaboration, and the production of solutions, align with vocational education's emphasis on work readiness, practice-based learning, and professional competence development (Billett, 2001; Ceelen et al., 2023). The novelty of this article therefore lies in repositioning studio-based learning as a pedagogical framework that can be adapted across vocational disciplines.

This review also challenges the narrow view that studio-based learning is synonymous with a physical studio space. Spatial qualities, atmosphere, materiality, and face-to-face interaction remain important dimensions of the studio (Fleischmann, 2021; Srirangam & Ng, 2022). Nevertheless, the development of blended, hybrid, flipped, and networked studios indicates that studio principles can be extended through technology, provided that the pedagogical design preserves critique, collaboration, reflection, and the production of work (Brown et al., 2015; Chan et al., 2023).

Challenges in Implementing Studio-Based Learning

The review identifies several challenges in implementing studio-based learning. The first concerns the open-ended nature of problems, which can foster creativity, critical thinking, and problem-solving but may also cause confusion when students do not understand the objectives, standards, or expected direction of their work (Cennamo et al., 2011; Kumar et al., 2021). Studio-based learning therefore requires adequate scaffolding, initial orientation, examples, rubrics, and feedback.

The second challenge concerns learner agency. Studio-based learning encourages students to manage their learning processes, make decisions, and develop their own strategies (Ryan et al., 2025; Sopher et al., 2025). However, freedom without structure can make learning unproductive. Instructors therefore retain important roles as facilitators, critics, coaches, and designers of the learning ecosystem (Cennamo & Brandt, 2012; Kumar et al., 2021).

Technology, however, does not automatically replace the dynamics of the physical studio, particularly spontaneous interactions, hands-on work with materials, the studio atmosphere, and a sense of community (Fleischmann, 2014; Srirangam & Ng, 2022). Technology integration in studio-based learning should therefore be designed to extend its pedagogical possibilities rather than merely transfer the studio environment to digital platforms.

The fourth challenge concerns assessment. Studio-based learning requires formative assessment that captures students' processes, products, reflection, revision, and competency development (McArthur, 2023; McLachlan & Tippett, 2024). Rubrics can clarify expectations and support self-assessment but may become mechanical when used solely as administrative instruments.

The fifth challenge concerns scalability. Studio-based learning requires sufficient time, facilities, opportunities for interaction, intensive feedback, and appropriate instructor-to-student ratios (Brown et al., 2015; Meissner et al., 2025). Implementation in large classes or intensive formats can succeed when supported by well-designed interactions, effective coordination, technology, and time management. Thus, in response to the research question concerning enabling conditions for implementation, studio-based learning is effective when supported by

scaffolding, high-quality feedback, instructor readiness, studio facilities, technology access, a collaborative culture, and connections to professional contexts.

Theoretical Contributions

This article contributes theoretically by conceptualizing studio-based learning as vocational pedagogy for developing 21st-century competencies through the integration of three conceptual domains: studio pedagogical characteristics, vocational education principles, and 21st-century competencies. This integration is important because vocational education requires learning approaches that bring together technical skills, professional ways of thinking, collaboration, communication, creativity, and adaptability (Billett, 2001; Thornhill-Miller et al., 2023).

The second contribution lies in explaining the pedagogical mechanisms that make studio-based learning relevant to the development of 21st-century competencies. These mechanisms include authentic problem engagement, iterative making and improvement, dialogic critique and feedback, collaborative knowledge construction, reflective professional learning, self-directed inquiry, and digital/hybrid studio mediation. By articulating these mechanisms, the article explains both the benefits of studio-based learning and how and under what conditions those benefits may emerge (Brandt et al., 2013; Brocato, 2009; Cennamo et al., 2011).

The third contribution is the development of the Studio-Based Learning for Vocational 21st-Century Competence Development Framework. This framework proposes that studio-based learning operates through a sequence of relationships linking studio characteristics, alignment with vocational education, pedagogical mechanisms, the development of 21st-century competencies, and the preparation of future-ready vocational graduates. The article thus offers a conceptual foundation that can be tested in subsequent empirical research.

Practical Implications for Vocational Education

A practical implication of this review is that vocational education should structure studio-based learning as a complete learning cycle encompassing problem exploration, ideation, prototyping, critique, reflection, revision, presentations of work, and process evaluation. This cycle aligns with the emphasis of studio-based learning on learning through action, dialogue, and iterative improvement (Brocato, 2009; Cennamo et al., 2011). Vocational education curricula should provide greater opportunities for authentic projects connected to the business sector. Such projects can help students understand that vocational competence involves not only technical abilities but also the capacity to interpret contexts, communicate with stakeholders, and produce relevant solutions (Ceelen et al., 2023; McArthur, 2023).

Vocational instructors should be positioned as facilitators, critics, coaches, and designers of learning experiences. These roles are important because studio-based learning requires intensive feedback, reflective questioning, modeling, meta-discussion, and strategic guidance (Cennamo & Brandt, 2012; Kumar et al., 2021). Institutions should also support instructors' professional development in authentic project design, studio critique, portfolio assessment, formative feedback, and the use of technology in hybrid studios.

Assessment in studio-based learning should give balanced attention to both processes and products. Portfolios, reflective rubrics, peer feedback, presentations of work, reflective journals, and process documentation can be used to assess students' competency development (McArthur, 2023; McLachlan & Tippett, 2024). Technology integration should also strengthen collaboration, process documentation, access to learning resources, and feedback. Chan et al. (2023) show that open educational resources can enhance a studio-based flipped classroom, while Brown et al. (2015) demonstrate that blended studios can help adapt studio practices to large classes.

Limitations and Directions for Future Research

As a conceptual review, this article is limited by the absence of empirical testing of the effectiveness of studio-based learning. Claims regarding its relevance should be understood as theoretical arguments developed through a synthesis of the literature rather than as findings derived from statistical analysis. Future research should therefore test the proposed conceptual framework through empirical studies across diverse vocational education contexts.

Conclusion (خاتمة)

This article aims to articulate the relevance of studio-based learning to the development of 21st-century competencies in vocational education through a conceptual review grounded in an integrative literature review approach. The literature synthesis indicates that studio-based learning is particularly well suited to vocational education because it provides authentic, practice-based, reflective, collaborative, and iterative learning experiences oriented toward producing solutions. Its relevance lies in its capacity to cultivate professional ways of thinking, decision-making abilities, teamwork skills, and the ability to continuously improve performance.

The main findings indicate that studio-based learning contributes to the development of 21st-century competencies, particularly creativity, critical thinking, communication, collaboration, problem-solving, digital literacy, self-directed learning, adaptability, and professional readiness. These competencies develop through pedagogical mechanisms encompassing authentic problem engagement, iterative making and improvement, dialogic critique and feedback, collaborative knowledge construction, reflective professional learning, self-directed inquiry, and technological mediation in hybrid or blended studio models.

The main contribution of this article is the development of the Studio-Based Learning for Vocational 21st-Century Competence Development Framework. This framework positions studio-based learning as vocational pedagogy that connects studio characteristics, vocational education principles, pedagogical mechanisms, 21st-century competencies, and conditions supporting implementation. It extends the studio-based learning literature beyond design and architecture to the broader context of vocational education. In practice, instructors, curriculum developers, and vocational education institutions can use this framework to design learning experiences that are more authentic, reflective, collaborative, performance-based, and relevant to the workplace.

Nevertheless, this article is limited by its conceptual nature and does not empirically assess the effectiveness of studio-based learning. The literature reviewed also spans diverse fields, meaning that implementation may vary according to disciplinary context, facilities, instructor readiness, student characteristics, and institutional support. Further research is therefore needed to empirically test the proposed conceptual framework.

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