INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI August 2026 | Special Issue on Education

Inquiry-Based Learning as a Pedagogical Innovation for Virtual Construction Education

Ayesha Mall[1], Theodore C Haupt[2]

[1]Department of Construction Management and Quantity Surveying, Durban University of Technology, Durban, South Africa.

[2]Department of Construction Management, Nelson Mandela University, Gqeberha, South Africa

DOI: https://doi.org/10.47772/IJRISS.2026.1026EDU0485

Received: 15 July 2026; Accepted: 20 July 2026; Published: 03 August 2026

ABSTRACT

The rapid digital transformation of the construction industry is reshaping the knowledge, skills and competencies required of construction graduates. As higher education increasingly adopts virtual and blended learning environments, there is growing recognition that traditional lecturer-centred teaching approaches are insufficient for developing the critical thinking, problem-solving, collaboration and professional judgement required for contemporary construction practice. This paper examines the role of Inquiry-Based Learning (IBL) as a pedagogical innovation for virtual construction education within the South African higher education context. A qualitative research approach was adopted using a desktop-based systematic literature review to critically synthesise the existing literature on constructivism, IBL, virtual learning and construction education. The review identified five interrelated themes, namely pedagogical transformation, the limitations of traditional pedagogies, IBL as a constructivist pedagogy, virtual learning and graduate preparedness. The findings indicate that IBL provides an effective pedagogical framework for promoting active learning, collaboration, reflection and knowledge construction within virtual learning environments, while strengthening the higher-order competencies required for professional construction practice. The paper further proposes a conceptual framework that integrates constructivist learning theory, IBL and virtual construction education to support curriculum transformation within South African higher education. The framework offers both a theoretical foundation and practical guidance for educators seeking to design more engaging, student-centred and professionally relevant virtual learning environments.

Keywords: Inquiry-Based Learning; Virtual Construction Education; Constructivism; Construction Education; Higher Education; South Africa.

INTRODUCTION

The construction industry is undergoing significant transformation as a result of rapid technological advancement, digitalisation, increasing project complexity and changing industry requirements. Consequently, construction graduates are expected to possess not only technical competence but also higher-order skillsets such as critical thinking, problem-solving, collaboration, communication, adaptability and digital literacy to effectively contribute to industry needs (Bilbo et al., 2000; OECD, 2024, 2026a; Pan & Zhang, 2021; Unesco, 2023). These changing industry requirements have placed increasing pressure on higher education institutions (HEIs) to ensure that construction programmes prepare graduates who are capable of responding to the evolving demands of the industry (Drewery et al., 2020; Moreau & Leathwood, 2006; Skrentny & Lewis, 2022; World Economic, 2025).

Within South Africa, this challenge is particularly important as the construction industry continues to experience skills shortages while simultaneously embracing digital technologies, sustainable construction practices and new methods of project delivery (Harinarain & Haupt, 2016; Haupt, 2009; Zulu, 2019). Although construction programmes continue to provide students with the technical knowledge required for professional practice, concerns remain regarding graduates' ability to apply this knowledge within complex project environments.

Employers have consistently identified shortcomings in graduates' problem-solving abilities, critical thinking, communication skills, teamwork and professional judgement, suggesting that there remains a disconnect between higher education and industry expectations (Ampofo-Anti, 2007; Ayarkwa et al., 2011; Chileshe & Haupt, 2007; Drewery et al., 2020; Haupt, 2012).

The disconnect between HEI's and industry expectations may be attributed, in part to the continued reliance on traditional instructor-centred pedagogies that position students as passive recipients of knowledge rather than active participants in the learning process (Biggs et al., 2022; Unesco, 2023). While these approaches remain effective for introducing theoretical concepts and technical knowledge, they often provide limited opportunities for students to actively engage in the learning process, develop critical thinking skills or apply practical knowledge to authentic construction problems (Armbruster et al., 2009; Barkley & Major, 2020; Biggs et al., 2022). Given the collaborative and problem-based nature of construction practice, there is an increasing need for pedagogical approaches that encourage active participation, knowledge construction and reflective learning. Student-centred pedagogies have therefore received growing attention as effective approaches for developing the higher-order competencies required within contemporary construction education (OECD, 2024; Unesco, 2023).

Inquiry-Based Learning (IBL) has emerged as one such pedagogical approach. Grounded in constructivist learning theory, IBL encourages students to investigate authentic problems, explore alternative solutions, collaborate with peers and construct knowledge through active engagement rather than passive reception of knowledge. (Harlen, 2013; Levy, 2009; Piaget, 1952; Spronken-Smith & Kingham, 2009; Vygotsky, 1978). These characteristics closely reflect the realities of construction practice, where professionals are required to analyse information, make informed decisions and work collaboratively to solve complex real life problems. Consequently, IBL has gained increasing recognition as an effective pedagogical approach for developing both disciplinary knowledge and the professional competencies required within the construction industry (Pedaste et al., 2015; Spronken-Smith & Kingham, 2009).

The rapid adoption of virtual and blended learning has further highlighted the need to reconsider how construction education is designed and delivered. Although digital technologies have expanded opportunities for teaching and learning, technology alone does not guarantee meaningful educational experiences. Rather, effective virtual learning depends on pedagogical approaches that promote active participation, collaboration, reflection and inquiry (Bozkurt & Sharma, 2020; Deniz Gökçe Erbil, 2020; OECD, 2024; Unesco, 2023). While IBL has been widely discussed across higher education, limited attention has been given to its conceptual application within virtual construction education, particularly within the South African context. Existing studies have focused on digital technologies or online delivery, with comparatively less emphasis on how pedagogical approaches can enhance student learning within virtual construction programmes (Bond et al., 2021; Bozkurt & Sharma, 2020; Deniz Gokce Erbil, 2020; Organisation for Economic & Development, 2026; Siddiqui et al., 2025). Therefore, this paper critically examines IBL as a pedagogical innovation for virtual construction education through a systematic synthesis of the literature. It explores the theoretical foundations of IBL, its relevance to construction education and its application within virtual learning environments.

LITERATURE REVIEW

The Changing Landscape of Construction Education in South Africa

The construction industry has undergone significant transformation due to technological advancement, digitalisation, sustainability requirements and increasingly complex project environments. These developments have reshaped the knowledge, skillsets and competencies expected of construction graduates, requiring HEI's to prepare students for rapidly evolving industry demands (Harinarain & Haupt, 2016; Pan & Zhang, 2021; Unesco, 2023). Consequently, construction education has evolved beyond technical competence to emphasise higher-order skills such as critical thinking, problem-solving, collaboration, communication and lifelong learning (Bilbo et al., 2000; Drewery et al., 2020; OECD, 2024).

Within South Africa, these challenges are compounded by concerns regarding graduate employability, curriculum transformation and the continued digitalisation of higher education. Although construction programmes provide students with the technical knowledge required for professional practice, employers continue to express concerns about graduates' ability to apply knowledge, solve complex problems and work effectively within multidisciplinary teams (Ampofo-Anti, 2007; Ayarkwa et al., 2011; Chileshe & Haupt, 2007; Drewery et al., 2020; Haupt, 2012).The concerns highlight the need for pedagogical approaches that better prepare students for the industry while responding to the diverse realities of digital and virtual learning.

The expansion of digital and blended learning has further reinforced the need to reconsider how construction education is designed and delivered. Although digital technologies have transformed access to learning, meaningful learning depends on pedagogical approaches that actively engage students rather than simply transferring traditional teaching methods to online platforms (Bozkurt & Sharma, 2020; OECD, 2024; Unesco, 2023). Consequently, increasing attention has been directed towards student-centred pedagogies that promote active learning, collaboration and critical thinking, providing a strong foundation for the adoption of IBL within construction education.

Limitations of Traditional Pedagogies in Construction Education

Traditional construction education has largely been characterised by lecture-based, instructor-centred teaching, where instructors are the primary source of knowledge and students are expected to acquire and reproduce information (Biggs et al., 2022). While these approaches remain effective for introducing theoretical concepts and technical principles, they provide limited opportunities for students to develop the critical thinking, problem-solving and collaborative skills required for contemporary construction practice (Armbruster et al., 2009; Barkley & Major, 2020). Subsequently, graduates may possess technical knowledge but struggle to apply that knowledge within complex project environments. Research emphasises that meaningful learning depends on active student engagement rather than the transmission of content alone (UNESCO, 2023; OECD, 2024).

These limitations are particularly evident in construction, where professionals are required to solve complex problems, work within multidisciplinary teams and make informed decisions under conditions of uncertainty. In South Africa, employers increasingly expect graduates to demonstrate professional judgement, communication, teamwork and digital competence in addition to technical expertise (Ampofo-Anti, 2007; Ayarkwa et al., 2011; Chileshe & Haupt, 2007; Haupt, 2012). This highlights the need for pedagogical approaches that encourage active participation, knowledge application and critical reflection.

Although traditional teaching continues to play an important role in developing disciplinary knowledge, it should be complemented by student-centred pedagogies that promote inquiry, collaboration and authentic problem-solving. Consequently, IBL has emerged as an appropriate pedagogical approach for preparing construction graduates for the complexities of contemporary professional practice (Deniz Gokce Erbil, 2020; Unesco, 2023).

Inquiry-Based Learning as a Constructivist Pedagogy

Constructivist learning theory views learning as an active process in which students construct knowledge through experience, interaction and reflection rather than passively receiving information (Piaget, 1952; Vygotsky, 1978; Dewey, 1938). It emphasises that meaningful learning occurs through engagement with authentic problems, collaboration and reflection, with instructors acting as facilitators who guide and scaffold the learning process rather than simply transmitting knowledge (Jonassen, 1999; Kivunja, 2014; Oviawe, 2016). These principles underpin IBL, where students actively investigate problems, evaluate evidence and construct knowledge through inquiry rather than passive content delivery. As a result, IBL is increasingly recognised as an effective student-centred pedagogy for developing higher-order thinking, collaboration and lifelong learning within HEI's. (OECD, 2024; UNESCO, 2023).

The principles are reflected in IBL, where learning is driven by investigation, questioning and problem-solving rather than content transmission. Students are encouraged to explore authentic problems, evaluate evidence and develop solutions through collaboration and critical reflection (Harlen, 2013; Levy, 2009; Pedaste et al., 2015; Spronken-Smith & Kingham, 2009). This approach is particularly relevant to construction education because it enables students to connect theoretical knowledge with professional practice while developing the analytical, collaborative and decision-making skills required within demanding project environments.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI August 2026 | Special Issue on Education

Within the South African context, IBL promotes active participation and shared knowledge construction while supporting graduate preparedness for professional practice. However, its successful implementation depends on appropriate guidance, scaffolding and timely feedback, particularly within virtual learning environments where purposeful interaction is essential for meaningful student engagement (Hmelo-Silver et al., 2007; Kirschner et al., 2006).

Virtual Learning and the South African Higher Education Context

The COVID-19 pandemic accelerated the adoption of virtual and blended learning across South African higher education, requiring HEI's to rapidly transition from face-to-face teaching to online delivery mode(Bozkurt & Sharma, 2020; UNESCO, 2023). While this ensured continuity of learning, it also exposed challenges relating to digital access, connectivity, student engagement and digital literacy, particularly within construction education where many learning activities have traditionally relied on face-to-face interaction. The developments reinforced the need for digitally inclusive learning environments that support equitable access and meaningful student engagement (Bond et al., 2021; OECD, 2024; UNESCO, 2023).

The rapid shift to virtual learning additionally demonstrated that technology alone does not guarantee meaningful learning. Rather, effective virtual education depends on student-centred pedagogical approaches that promote collaboration, problem-solving and critical reflection (Erbil, 2020; OECD, 2024). Virtual learning provides opportunities to prepare construction students for an increasingly digital profession through the use of online collaboration platforms, virtual simulations and Building Information Modelling (BIM). Integrating IBL within these environments can create authentic, engaging and practice-oriented learning experiences that strengthen both digital competence and graduate preparedness for contemporary construction practice (Pan & Zhang, 2021; OECD, 2024; UNESCO, 2023).

Inquiry-Based Learning in Virtual Construction Education

Virtual learning environments provide an appropriate platform for implementing IBL because they encourage active participation, collaboration and knowledge construction rather than passive content delivery. Through digital resources, discussion forums, collaborative activities and reflective tasks, students are able to investigate authentic construction problems and apply theoretical knowledge to practical situations (Pedaste et al., 2015; Erbil, 2020). Consequently, virtual learning can become a more meaningful and engaging educational experience when supported by inquiry-based pedagogies. Recent evidence suggests that the educational value of digital technologies depends not on access to technology alone, but on the extent to which learning activities promote interaction, collaboration, critical thinking and knowledge construction through purposeful pedagogical design (OECD, 2025; OECD, 2026; UNESCO, 2025).

Successful implementation of virtual IBL requires appropriate instructional design and scaffolding. Students should be guided through structured inquiry activities that encourage them to investigate problems, evaluate information, collaborate with peers and reflect on their learning, while instructors provide clear instructions, feedback and ongoing support (Hmelo-Silver et al., 2007; Kirschner et al., 2006). This is particularly important within the South African context, where differences in digital readiness and access to technology may influence students' ability to engage effectively in virtual learning. Contemporary research further emphasises that effective digital learning environments should provide continuous feedback, structured learner support and opportunities for meaningful interaction in order to sustain student engagement and improve learning outcomes (OECD, 2026; UNESCO, 2025).

For construction education, virtual IBL provides opportunities to replicate authentic professional practice through the use of digital case studies, project-based activities, virtual simulations, drawings and collaborative problem-solving. Although virtual learning cannot replace practical site experience, it can extend learning by enabling students to analyse complex construction problems, collaborate across digital platforms and develop the critical thinking, communication and professional skills required within the contemporary construction industry (Bozkurt & Sharma, 2020; OECD, 2024).

The continued digital transformation of the construction sector, including the widespread adoption of BIM, cloud-based collaboration platforms, artificial intelligence and digital project management systems, further reinforces the need for pedagogical approaches that integrate inquiry, collaboration and technology-enhanced learning to prepare graduates for contemporary professional practice (Pan & Zhang, 2021; OECD, 2026; UNESCO, 2025). Subsequently, integrating IBL within virtual construction education provides a pedagogically robust approach for developing graduates who are digitally competent, collaborative and capable of responding to the increasingly complex demands of the modern construction industry.

RESEARCH METHODOLOGY

This study adopted a qualitative research design using a systematic literature review to examine IBL as a pedagogical innovation for virtual construction education. A systematic literature review was considered appropriate because it provides a rigorous, transparent and reproducible approach for identifying, evaluating and synthesising existing knowledge within a particular research domain (Snyder, 2019). Unlike traditional narrative reviews, systematic literature reviews follow a structured protocol that minimises selection bias and enhances the credibility and reliability of the findings. Given the growing body of literature relating to constructivism, IBL, digital pedagogy and construction education, the systematic literature review approach enabled the integration of diverse theoretical and empirical perspectives to develop a comprehensive understanding of the role of IBL within virtual construction education in South Africa.

The review methodology comprised five sequential stages: (i) development of the search strategy, (ii) application of inclusion and exclusion criteria, (iii) screening and selection of studies, (iv) quality assessment of the selected literature, and (v) thematic analysis of the included studies.

Research Design and Search Strategy

The literature search was undertaken using six internationally recognised academic databases, namely Scopus, ScienceDirect, SpringerLink, Taylor & Francis Online, Emerald Insight and Google Scholar. These databases were selected because they provide extensive coverage of higher education, educational technology, construction education and engineering education literature.

A comprehensive search strategy was developed using combinations of keywords and Boolean operators to identify studies relevant to the objectives of the review. The principal search keywords such as "Inquiry-Based Learning" AND "Construction Education", "Constructivism" AND "Virtual Learning" , "Digital Pedagogy" AND "Higher Education" , "Construction Education" AND "South Africa", "Virtual Learning" AND "Graduate Employability".

Additional manual searches of the reference lists of highly cited publications were undertaken to identify seminal theoretical works relating to constructivism and IBL. Literature published between 2016 and 2026 was considered to capture contemporary developments in digital education while retaining foundational constructivist literature where theoretically appropriate

Inclusion and Exclusion Criteria

To ensure methodological consistency and relevance, predefined inclusion and exclusion criteria were established prior to the literature search. Studies were included if they:

- Examined IBL, constructivism, virtual learning, digital pedagogy, construction education or higher education;
- Published in peer-reviewed journals, conference proceedings, scholarly books or recognised policy reports;
- Published between 2016 and 2026, with seminal constructivist publications retained where appropriate;
- Published in English.

Studies were excluded if they:

- consisted of opinion articles, editorials or magazine publications;
- lacked relevance to the research objectives;
- focused exclusively on engineering practice without educational relevance;
- duplicated previously identified publications; or
- Non-English publications.

Following the database searches, duplicate publications were removed before the remaining records were screened according to their titles and abstracts. Studies that did not satisfy the inclusion criteria were excluded during this initial screening stage. The full texts of the remaining publications were subsequently reviewed to determine their relevance to the objectives of the study. Only studies that provided substantive theoretical, empirical or policy-related contributions relating to IBL, constructivism, virtual learning or construction education were retained for the final synthesis.

FINDINGS AND DISCUSSION

The thematic analysis of the selected literature identified five interrelated themes that explain the role of IBL as a pedagogical innovation for virtual construction education. Collectively, these themes demonstrate how constructivist principles can support the transformation of construction education by promoting active learning, collaboration, critical reflection and graduate preparedness within digital learning environments. Table 1 provides a synthesis of the principal themes, their key findings, implications for construction education and representative literature. The themes are subsequently discussed to illustrate their contribution to the proposed conceptual framework for virtual construction education in South Africa.

Table 1. Synthesis of the Principal Themes Identified in the Literature

Theme	Key finding	Implications for Construction Education	Representative literature
Pedagogical transformation	The changing construction industry requires a shift towards student-centred pedagogies that develop higher-order thinking, digital competence and graduate employability.	Construction curricula should move beyond technical knowledge to develop critical thinking, collaboration, problem-solving and lifelong learning through innovative teaching approaches.	Bilbo et al. (2000); Drewery et al. (2020); Pan & Zhang (2021); UNESCO (2023); OECD (2024); OECD (2026); World Economic Forum (2025)
Limitations of traditional pedagogies	Traditional lecture-based teaching effectively develops disciplinary knowledge but provides limited opportunities for authentic learning, higher-order thinking and collaborative problem-solving.	Construction programmes should integrate active and student-centred learning approaches that better reflect the realities of professional construction practice.	Biggs & Tang (2022); Barkley & Major (2020); Jonassen et al. (1999); Erbil (2020); Bond et al. (2021); UNESCO (2023); OECD (2024)
Inquiry-Based Learning	Inquiry-Based Learning promotes active learning, collaboration, reflection and knowledge construction through authentic inquiry grounded in constructivist learning theory.	Inquiry-based activities should be embedded within construction curricula to encourage investigation, decision-making, reflective practice and the application of knowledge to authentic construction problems.	Piaget (1952); Dewey (1938); Vygotsky (1978); Harlen (2013); Pedaste et al. (2015); Hmelo-Silver et al. (2007); UNESCO (2023); OECD (2024)

Virtual learning	Virtual learning environments enhance Inquiry-Based Learning when supported by appropriate pedagogical design, effective scaffolding and meaningful student engagement.	Virtual construction education should combine synchronous and asynchronous learning with collaborative inquiry, structured support and authentic digital learning experiences.	Bozkurt & Sharma (2020); Erbil (2020); Bond et al. (2021); UNESCO (2023); OECD (2024); OECD (2026b)
Graduate preparedness	Inquiry-Based Learning develops critical thinking, communication, collaboration, digital competence and professional judgement required for contemporary construction practice.	The integration of Inquiry-Based Learning within virtual construction education can strengthen graduate employability and better align higher education with the evolving needs of the construction industry.	Harinarain & Haupt (2016); Haupt (2012); Ayarkwa et al. (2011); Drewery et al. (2020); Pan & Zhang (2021); World Economic Forum (2025); (OECD, 2026b)

Construction Education Requires Pedagogical Transformation

The literature consistently demonstrates that the changing nature of the construction industry has altered the competencies expected of construction graduates. Rapid advances in digital technologies, sustainability requirements and increasingly complex project environments have shifted the focus of construction education beyond technical knowledge towards the development of critical thinking, collaboration, communication and problem-solving skills (Bilbo et al., 2000; Drewery et al., 2020; Pan & Zhang, 2021; UNESCO, 2023; OECD, 2024; World Economic Forum, 2025). Within South Africa, these challenges are further shaped by graduate employability, curriculum transformation and the digitalisation of higher education (Harinarain & Haupt, 2016; Haupt, 2012). Consequently, construction education requires pedagogical approaches that better prepare graduates for contemporary professional practice.

The review therefore identifies pedagogical transformation as a central requirement for contemporary construction education. Rather than focusing solely on the transmission of disciplinary knowledge, construction programmes are increasingly expected to develop graduates who can apply knowledge within authentic professional contexts, collaborate across multidisciplinary teams and adapt to rapidly changing industry environments. This finding reflects a broader shift within higher education towards student-centred learning approaches that emphasise active participation, critical inquiry and lifelong learning (OECD, 2024; UNESCO, 2023).

In South Africa, this transformation is particularly important because HEI's are required to address both industry expectations and the ongoing digital transformation of teaching and learning. The findings therefore suggest that curriculum transformation should not be limited to the incorporation of new technologies, but should also include the adoption of pedagogical approaches that promote higher-order thinking, collaboration and authentic knowledge construction. This provides a strong foundation for the implementation of IBL as an appropriate pedagogical framework for virtual construction education.

Inquiry-Based Learning Supports Student-Centred Learning

Student-centred learning has become increasingly important in construction education as programmes respond to the need for more active, participatory and reflective forms of learning. Within this context, IBL provides a theoretically appropriate pedagogical approach by positioning students as active participants in the learning process and encouraging investigation, collaboration and reflection (Harlen, 2013; Pedaste et al., 2015; UNESCO, 2023; OECD, 2024).

These characteristics closely align with constructivist learning theory and support the development of higher-order cognitive skills required within construction practice. The literature therefore suggests that IBL provides a more authentic learning experience by enabling students to connect theoretical knowledge with real-world construction problems.

The synthesis of the reviewed literature further indicates that IBL extends beyond the acquisition of disciplinary knowledge by encouraging students to actively construct understanding through inquiry, collaboration and reflective practice. Rather than positioning students as passive recipients of information, IBL promotes student autonomy, critical thinking and evidence-based decision-making, competencies that closely mirror the demands of professional construction practice (Pedaste et al., 2015; OECD, 2024; UNESCO, 2023). These findings reinforce the view that meaningful learning occurs when students actively engage with authentic problems and participate in the co-construction of knowledge.

However, in South Africa, this finding has important implications for curriculum transformation. As HEI's continue to respond to graduate employability challenges and increasing digitalisation, the adoption of IBL provides an opportunity to create more engaging and professionally relevant learning experiences. The review therefore suggests that embedding IBL within construction programmes can strengthen the integration of theoretical knowledge with professional practice while supporting the development of the higher-order competencies required by the contemporary construction industry (Pan & Zhang, 2021; Drewery et al., 2020; World Economic Forum, 2025).

Virtual Learning Enhances Inquiry-Based Learning

The literature further indicates that virtual learning environments can effectively support IBL when underpinned by appropriate pedagogical design. Rather than simply transferring lectures to online platforms, virtual learning should encourage collaboration, inquiry, reflection and active participation through digital resources, discussion forums and problem-based activities (Bozkurt & Sharma, 2020; Erbil, 2020; OECD, 2024; UNESCO, 2023; OECD, 2026).

The synthesis of the reviewed literature indicates that the effectiveness of virtual learning is determined primarily by pedagogy rather than technology itself. Across the reviewed studies, meaningful learning was consistently associated with learning environments that promote student interaction, collaborative knowledge construction and reflective inquiry rather than passive content delivery (Bond et al., 2021; UNESCO, 2023; OECD, 2024; OECD, 2026). This finding suggests that virtual learning environments should be viewed as pedagogical spaces that enable inquiry, rather than simply as digital platforms for delivering instructional content.

Figure 1 presents the conceptual relationship between IBL and virtual construction education developed from the synthesis of the reviewed literature. The framework illustrates how constructivist learning principles underpin IBL and facilitate active learning, collaboration, reflection and problem-solving within virtual learning environments, ultimately supporting graduate preparedness for contemporary construction practice.

The significance of the framework lies in its integration of the principal themes identified throughout the review into a coherent conceptual model. It demonstrates that effective virtual construction education depends on the interaction between constructivist learning principles, IBL and purposeful pedagogical design, rather than on the use of technology alone.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI August 2026 | Special Issue on Education

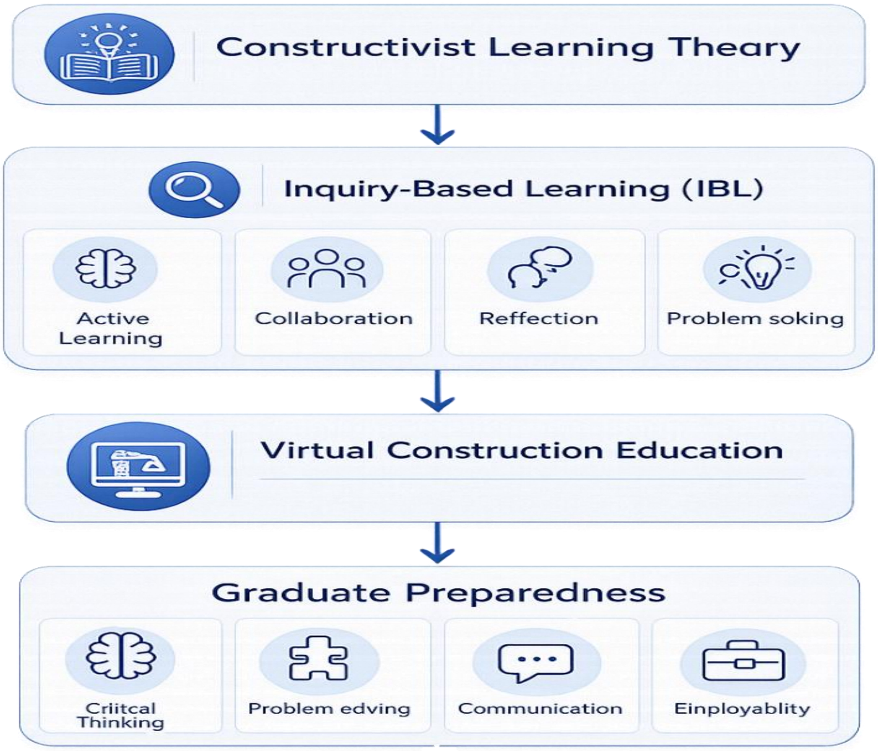

Figure 1. Inquiry-Based Learning as a Pedagogical Framework for Virtual Construction Education

Source: Developed by the author from Dewey (1938), Piaget (1952), Vygotsky (1978), Jonassen et al. (1999), Harlen (2013), Pedaste et al. (2015), Spronken-Smith and Kingham (2009), Bozkurt and Sharma (2020), and OECD (2024).

Inquiry-Based Learning Supports Graduate Preparedness

A recurring theme identified from the literature is that IBL contributes to graduate preparedness by developing competencies that extend beyond disciplinary knowledge. Through engagement with authentic construction problems, collaborative learning and reflective practice, students develop critical thinking, communication, teamwork and professional judgement, all of which are essential for contemporary construction practice (Harlen, 2013; Pedaste et al., 2015; Spronken-Smith & Kingham, 2009). These competencies align closely with industry expectations, where graduates are increasingly required to demonstrate adaptability, problem-solving abilities and effective collaboration within multidisciplinary project environments (Drewery et al., 2020; Harinarain & Haupt, 2016; Haupt, 2012; World Economic Forum, 2025; OECD, 2026).

The synthesis of the reviewed literature further indicates that graduate preparedness should be viewed as a multidimensional outcome of construction education, encompassing not only technical competence but also higher-order cognitive, interpersonal and digital capabilities. Across the reviewed studies, IBL was consistently associated with the development of student autonomy, critical inquiry, collaborative decision-making and reflective practice, all of which are recognised as essential competencies for contemporary professional practice (UNESCO, 2023; OECD, 2024; World Economic Forum, 2025). These findings suggest that IBL provides a more authentic preparation for construction practice by enabling students to apply theoretical knowledge within realistic and often complex professional contexts.

Within the South African context, the literature suggests that adopting IBL can contribute to curriculum transformation by bridging the gap between academic learning and professional practice. By promoting active participation and the application of knowledge to authentic construction scenarios, IBL has the potential to enhance graduate employability and better prepare students for the evolving demands of the construction industry (Ayarkwa et al., 2011; Chileshe & Haupt, 2007; Pan & Zhang, 2021). As the construction sector

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue XXVI August 2026 | Special Issue on Education

continues to embrace digitalisation, sustainability and collaborative project delivery, HEI's must ensure that graduates possess the competencies required to operate effectively within increasingly complex professional environments. The findings therefore suggest that embedding IBL within virtual construction education provides an effective means of strengthening graduate preparedness while supporting ongoing curriculum transformation and the long-term sustainability of the construction profession in South Africa (OECD, 2026; World Economic Forum, 2025).

Proposed Conceptual Framework

Based on the synthesis of the reviewed literature, this paper proposes a conceptual framework for integrating IBL within virtual construction education as shown in Figure 2. Grounded in constructivist learning theory, the framework positions IBL as the central pedagogical approach for promoting active learning, collaboration, reflection, engagement, social interaction, reflective practice and scaffolding within virtual learning environments (Dewey, 1938; Piaget, 1952; Vygotsky, 1978; Pedaste et al., 2015). Additionally, the framework reflects recent perspectives that emphasise learner-centred pedagogies as essential for effective digital and virtual education (UNESCO, 2023; OECD, 2024; OECD, 2026).

Figure 2 presents the proposed conceptual framework developed from the synthesis of the reviewed literature. It represents the principal theoretical contribution of this paper by illustrating how changes within the construction industry drive pedagogical transformation, with IBL serving as the mechanism through which active learning, collaboration and reflective practice contribute to graduate preparedness.

The framework provides a conceptual foundation for curriculum transformation and offers practical guidance for instructors seeking to design more engaging, student-centred and professionally relevant virtual learning environments within South African construction education. It further provides a basis for future empirical studies to validate and refine the proposed relationships across different construction education contexts.

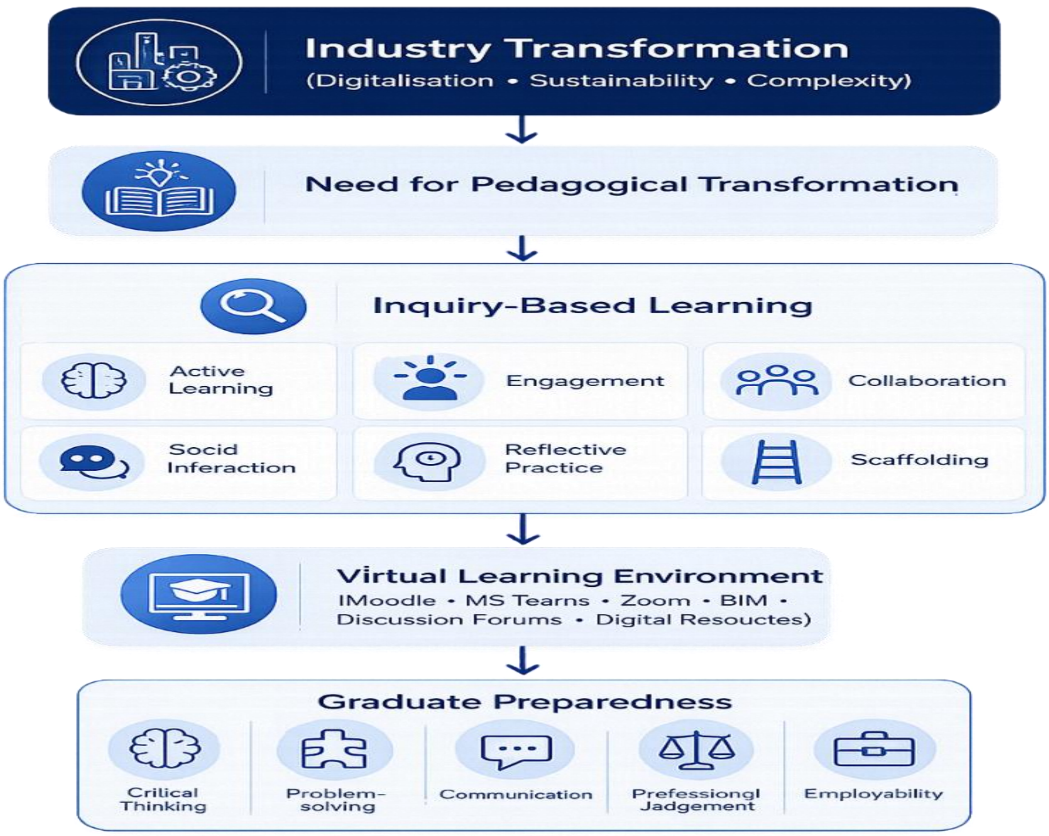

Figure 2. A Conceptual Framework for Integrating Inquiry-Based Learning within Virtual Construction Education

Source: *Researchers own*

CONCLUSION

This paper examined IBL as a pedagogical innovation for virtual construction education through a systematic literature review. The review demonstrates that the changing nature of the construction industry requires HEI's to adopt pedagogical approaches that extend beyond the transmission of technical knowledge towards the development of critical thinking, problem-solving, collaboration and professional judgement. Within the South African context, these changing demands reinforce the need for curriculum transformation that better prepares graduates for contemporary construction practice.

The findings indicate that IBL provides an appropriate pedagogical framework for supporting active learning, collaboration, reflection, engagement, social interaction, reflective practice and scaffolding within virtual learning environments. Grounded in constructivist learning theory, IBL enables students to engage with authentic construction problems while developing the professional competencies required by an increasingly digital and complex construction industry. The review further highlights that the effectiveness of virtual learning depends not only on technology, but also on the adoption of student-centred pedagogies supported by appropriate instructional design and scaffolding.

A key contribution of this paper is the proposed conceptual framework, which synthesises the principal themes identified in the literature and demonstrates how IBL can enhance graduate preparedness within virtual construction education. The framework provides both a theoretical contribution to the construction education literature and practical guidance for curriculum design within South African HEI's.

The transformation of construction education will depend not only on advances in digital technologies, but also on the adoption of pedagogical approaches that actively engage students in the construction of knowledge. IBL offers a practical and theoretically grounded framework for supporting this transformation and preparing graduates to meet the evolving demands of the South African construction industry.

Limitations and Future Research

The study is based on a systematic synthesis of existing literature and therefore does not empirically evaluate the proposed conceptual framework within virtual construction education settings. Consequently, the relationships presented in the framework should be interpreted as conceptually derived rather than empirically verified. Future research should validate the framework through case studies, surveys, experimental research or mixed-methods investigations involving construction students and educators within South African HEI's. Such empirical studies would provide further insight into the effectiveness of IBL in enhancing student engagement, higher-order thinking and graduate preparedness within virtual construction education.

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