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CONSTRUCTION 5.0: EXPLORING DIGITAL SKILL GAPS IN CONSTRUCTION EDUCATION

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Abstract

Digitalization is transforming the construction industry, yet gaps persist between industry needs and educational training. Current curricula emphasize broad digital literacy but lack structured training in AI (Artificial Intelligence), BIM (Building Information Modeling), and automation, leaving students underprepared for digital workflows. This study applies a mixed-methods approach, combining surveys and interviews with students and educators, to assess digital skill gaps. Findings highlight mismatches between student expectations, educational priorities, and industry demands. The study highlights the importance of interdisciplinary collaboration, structured AI training, and closer alignment between industry and education. Recommendations include curriculum enhancements and practical exposure to digital tools to better equip future construction professionals.

Introduction

The construction industry is at a crucial point of digital transformation, moving beyond the initial wave of digitalization characterized by Industry 4.0 (I4.0) technologies, often adapted as Construction 4.0 (C4.0) in the construction sector. These frameworks have emphasized technological advancements in the construction sector, such as Building Information Modelling (BIM), digital twins, IoT, and robotics to enhance productivity, reduce costs, and improve safety (European Commission, 2022). In recent years, Artificial Intelligence (AI) has also entered the construction domain, with growing interest in adopting intelligent systems and decision-support tools.

However, there is increasing recognition that technology alone cannot meet the challenges and opportunities of the future construction sector. To fully realize the benefits of digitalization, technology must be integrated with human expertise and work processes. Industry 5.0, often adopted as Construction 5.0, represents a shift toward a more human-centered approach. It promotes the integration of advanced technologies with human insight to foster collaboration, sustainability, and continuous learning (European Commission, 2021).

Previous studies within this field suggest that skill gaps, particularly in digital literacy and understanding of AI, pose significant barriers to digitalization and AI adoption (Adriaanse et al., 2010; Author et. al, 2025). This issue is especially prominent among non-management construction workers, who often lack the necessary training or understanding to utilize these tools fully (Rafsanjani & Nabizadeh, 2023). Without targeted upskilling, the potential for widespread adoption of modern technology, like AI-driven processes, remains limited (Zirar et al., 2023).

In this context, education plays a pivotal role in preparing the next generation of construction professionals. Several studies have identified a persistent mismatch between the digital competencies demanded by industry and those developed through formal education. Wu et al., (2018) highlight that students often lack practical, career-specific digital skills, which hinders their transition into the workforce. Lojda et al., (2020) emphasize the need for universities to facilitate the transfer of competence across generations, particularly in aging workforces. While BIM tools and software access are relatively well established in Norway, such as NTNU's specialization in digital design and construction processes (Banh, 2023). This does not always translate into consistent or structured digital training across programs.

As early as 2013, (Jupp & Awad, 2013) proposed a design thinking-led model that integrates user needs, problem-solving, and applied learning into construction management education, an approach that has gained renewed relevance in light of ongoing digital transformation. Similarly, new teaching materials developed by professors at the Norwegian University of Science and Technology (NTNU) and OsloMet reflect this shift by combining hands-on BIM training (e.g., Revit) with information management and collaborative processes. Rather than focusing solely on technical problem-solving, the material links program, process, and profession, emphasizing how BIM is applied in real-world project workflows (Hjelseth & Tollnes, 2022).

This research addresses the critical need to equip future construction workers with the digital competencies required to thrive in a rapidly evolving, technology-driven sector. By examining how "digitalization" is addressed in education and assessing the digital literacy of future construction professionals, including students from vocational high schools specializing in construction trades and university students in construction engineering programs, this initial investigation aims to provide a first assessment of student awareness of essential digital skills and educator perspectives on current educational approaches. The primary goal is to identify knowledge and training gaps related to digital technologies in construction. The study is based on a limited sample, including approximately 100 students from NTNU and two high schools in Norway, as well as interviews with 10 educators at NTNU.

Theoretical background

Digital education in Norway

In Norway, digital skills are recognized as a foundational competency alongside reading, writing, numeracy, and oral skills. According to the Norwegian Directorate for Education and Training (Udir), digital competence includes obtaining and processing information, communicating and collaborating in digital environments, and using digital resources creatively and responsibly (Udir, 2022)

In vocational programs such as Building and Construction Technology, digital skills are framed around appropriate use, critical evaluation of online information, communication, and digital judgment (Udir, 2020)

At the higher education level, the Norwegian Association of Higher Education Institutions (UHR) requires engineering students to develop competencies in ICT, programming, and cybersecurity (UHR, 2018). The Directorate for Higher Education and Skills further defines digital proficiency across three levels, emphasizing progression from basic tool use to reflective, critical application. Together, these frameworks confirm that digital skills are a cross-cutting priority in Norwegian education, focusing on responsible tool use, collaboration, and adaptability, traits essential for a digitalizing construction sector.

Still, challenges remain. The 2023 International Computer and Information Literacy Study (ICILS), shows a decline in Norwegian students' digital performance since 2013, despite remaining above the international average (Rohatgi et al., 2024). While students commonly use digital tools for presentations and research, more advanced or industry-specific applications are less emphasized.

A 2025 BCG report also notes that the Nordic region lags in Generative AI (GenAI) adoption. In Norway, only 24% of white-collar workers use GenAI weekly, compared to a European average of 54%. Limited upskilling and training are cited as major barriers to broader implementation (Grey et al., 2025).

Construction 5.0 skills

Silwal & Safapour, (2024) identify both hard skills (e.g., digital literacy, programming) and soft skills (e.g., problem-solving, teamwork) as essential for transitioning to Construction 5.0. Zirar et al., (2023) further categorize AI-related competencies into technical, human, and conceptual domains, while Siriwardhana & Moehler, (2023) highlight the importance of non-technical, cognitive, emotional, and managerial skills. Together, these studies highlight the need for a balanced skillset that integrates technical proficiency with human-centric and conceptual capabilities to effectively navigate digital integration in construction.

Research method

Research design

This study employs a mixed-methods approach, combining a quantitative survey with qualitative interviews to explore the perceptions of digital competencies among vocational high school and university-level construction students, as well as their educators. The survey assesses students' awareness of essential digital skills and how effectively their education addresses these needs, while interviews offer deeper insights into the integration of digital tools and competencies into construction-related curricula. An abductive research approach was employed to facilitate an iterative movement between empirical findings and theoretical concepts. Unlike purely deductive or inductive methods, abduction supports the refinement of interpretations throughout the research process, particularly relevant in socio-technical contexts where human, organizational, and technological factors interact in complex ways (Awuzie & McDermott, 2017). In this study, findings were continuously compared with existing theories on digital literacy and education, enabling the identification of both expected and emerging patterns. This flexible methodology supports practical insights for curriculum development and contributes to theoretical discussions on digital skill formation in construction education.

Participants

The study includes participants from two main groups:

1. **Students**: Students enrolled in construction education programs, both from vocational programs at two upper secondary schools in Sør-Trøndelag County, Norway, as well as engineering students enrolled in 3-year Bachelor's and 5-year Master's education programs at NTNU. This group provides insight into future construction workers' perspectives on digital skills, educational relevance, and readiness for industry demands.
2. **Educators**: professors, associate professors, and lecturers in construction-related educational programs at NTNU. Their input sheds light on how curricula address digitalization and prepare students for the evolving requirements of the construction industry.

Data collection

A survey was conducted to collect quantitative data from construction students about their digital skills and educational experiences. The survey focused on the following key areas: 1) Expectations for digital tool usage, 2) Relevance of education, 3) Digital tool training, 4) Personal competencies, and 5) Open-ended feedback

Qualitative interviews were conducted with educators in construction-related educational programs to gain deeper insight into 1) How digital tools and technologies are integrated into teaching, 2) Challenges faced in aligning curricula with digital competency requirements, and 3) Perspectives on the future skill needs of construction workers, particularly related to digitalization and interdisciplinary collaboration.

To gain additional insights into students' expectations for digital skills, informal conversations were conducted with students at NTNU. The discussions aimed to complement survey findings by exploring students' awareness of digital tools, their exposure to digital training during their education, and their perspectives on industry expectations.

Limitations of the study

This exploratory study provides initial insights into digital skill gaps in construction education but has several limitations. The sample includes both vocational and university students, offering breadth but introducing variability in digital experience, which limits group-specific conclusions. Interviews were limited to university educators due to time constraints and their role in curriculum design; including high school educators could offer a more complete perspective. Focus groups involved only university students, as high school participants were excluded from qualitative activities. Future research should address this gap. As an early-stage investigation, the study is intended to identify trends rather than provide comprehensive conclusions.

Results from student survey

Demographics and background information

The student survey received 86 responses, with participants from secondary school programs (34.9%), bachelor's degree programs (53.5%), and master's degree programs (11.6%), including both two-year and five-year programs. Regarding practical experience, 46.8% of respondents reported having no prior construction experience, while 43.0% had completed internships or part-time work, and 10.1% had full-time experience in the construction industry.

Expectations for digital tool usage

Students were asked about their expectations for the future use of digital tools in construction, including BIM, drones, digital communication platforms, and AI. Responses were measured on a scale from "Less than today" to "Much more than today." All percentages are based on the number of respondents to each individual question.

Across the total sample, AI (76%) and drones (73%) were expected to experience the most significant increase in use, followed by BIM (68%), scanners (66%), and VR goggles (46%). In contrast, laptops and smartphones were seen mainly as stable technologies, with 34% expecting their use to remain unchanged. "Don't know" responses were notably high for VR-goggles (22%) and scanners (16%), indicating limited exposure to these technologies.

Clear differences emerged across student groups. Master students showed the highest confidence, with 100% expecting increased use of all key technologies and no "don't know" responses. Bachelor students also expressed optimism, especially toward AI (89%) and drones (82%), but showed more variability and higher uncertainty, particularly regarding VR. High school students were more cautious, with consistently higher "don't know" responses, 30% for BIM, 25% for scanners, and 10% for AI, and generally lower expectations for increased use.

When asked about the digital tools they expected to learn after graduation, 65–74% of students anticipated acquiring skills in AI, drones, and BIM primarily through on-the-job training. Bachelor students had the strongest expectations for post-graduation learning in modelling tools, AI, and smart work tools. Master's students are also expected to deepen their skills in selected areas, likely reflecting prior exposure and a more focused understanding of which tools are most relevant to their future roles. In contrast, high school students had the highest proportion of "don't know" responses and lower expectations overall, particularly regarding BIM collaboration, smart tools, and AI.

Digital tool training in education

Students were also asked which digital tools they had encountered in their education or internships and to rate their level of training, from "No training" to "Comprehensive training." Usage and training experiences varied significantly across tools and student groups.

Communication and collaboration tools (e.g., Microsoft Teams, Slack) were the most widely used, with 79% reporting use, primarily self-taught. General AI tools (e.g., ChatGPT, Microsoft Copilot) were used by 73%, yet only 10% had received any formal training, indicating a gap between practical use and structured learning. Around 50% of students, mainly those pursuing bachelor's and master's degrees, had experience with programming tools such as Python or R, in line with programming being a mandatory subject in many higher education programs.

Among discipline-specific tools, 45% had used ArchiCAD, while all other technologies, including Revit, Solibri, drones, VR/AR, and 3D scanning, were used by fewer than 19% of respondents. Use was especially limited among high school students, while bachelor's and master's students reported slightly broader exposure.

When asked which tools they would like to learn, students most frequently mentioned Revit and drones (19 responses each), followed by 3D printing (15), 3D scanning (14), and VR/AR (11). Interest in other tools

Table 1: Comparison of Student Expectations for future use, Educational Training, and Industry Perspectives on Digital Tools in Construction. Industry perspectives are based on synthesis of previous literature. (Brozovsky et al., 2024; Chowdhury et al., 2019; European Commission, 2022; Rane, 2023).

	Master	Bachelor	High school	Training received in education	Industry perspective
AI	100 %	89 %	50 %	Very limited. 15% reported receiving formal training. Gen AI mainly self-thought	AI-powered decision-support is expected to automate planning and routine tasks and improve analytics for cost and risk management. However, it requires workers to understand AI limitations and interpret AI-generated insights critically.
DRONES	100 %	82 %	50 %	Very limited. 3% received formal training	Drones are increasingly used for site inspections and progress monitoring. Integrating drone data with BIM and AI-driven analytics can improve site safety and efficiency.
BIM	100 %	78 %	43 %	Limited formal training has been given, ranging from 5-60% in different BIM software.	BIM facilitates better collaboration, data integration, and project visualization. Future developments focus on extending BIM capabilities with 4D (time), 5D (cost), and AI-enhanced predictive modeling.
SCANNER	90 %	75 %	43 %	Very limited. 9% received formal training	Scanning is used for documentation and quality control. Integration with digital twins can improve construction accuracy and reduce rework costs.
DIGITAL COM.	60 %	63 %	64 %	Limited. 26% received formal training	Digital collaboration tools (e.g., Teams, Slack) essential for remote coordination. Standardizing industry-wide platforms and ensuring interoperability across stakeholders remains a challenge.
SMART PHONE	60 %	61 %	63 %	Very limited. 13% received formal training in mobile apps for field work	Smartphones are already widely used for on-site reporting, accessing project data, and communication. AI-assisted voice commands and AR-assisted work instructions may be included.
TABLET	80 %	69 %	33 %	-	Tablets are increasingly used for on-site documentation, digital inspections, and real-time data visualization.
VR-GOGGLES	90 %	47 %	30 %	Very limited. 3% received formal training	VR is gaining traction in design reviews, safety training, and immersive construction planning. Widespread adoption requires cost reductions and improved usability for real-world construction tasks
LAPTOP	50 %	74 %	38 %	-	Laptops remain essential for office-based tasks, but the shift towards cloud-based workflows means more data access via mobile and web applications, reducing reliance on heavy hardware

ranged from 1 to 8 responses, suggesting that a small set of emerging technologies stand out as priority areas for student upskilling, while others remain less visible or perceived as less relevant.

Table 1 summarizes overall student expectations for increased use, educational training, and industry perspectives on digital tools in construction. Industry perspectives reflect widely acknowledged trends in construction digitalization, as discussed in (Brozovsky et al., 2024; Chowdhury et al., 2019; European Commission, 2022; Rane, 2023).

Personal competencies for digitalization

Students assessed the importance of various interdisciplinary and personal skills, including collaboration, communication, adaptability, conflict resolution, and interdisciplinary understanding, for succeeding in a digital construction environment. Across the entire sample, these competencies were widely valued, with ratings ranging from 76% to 93% of students considering them essential or very important. Collaboration skills ranked highest (93%), followed by communication skills (90%) and adaptability and learning ability (89%). Interdisciplinary understanding received the lowest, but still substantial, support at 76%.

Notable differences emerged between educational backgrounds. Bachelor's students consistently rated personal competencies highly, with 69–76% selecting them as very important for collaboration, communication, and adaptability. Master students emphasized these competencies even more strongly, particularly collaboration (90%) and communication (70%), although they showed a slightly more varied view on project management and conflict resolution. In contrast, high school students expressed more uncertainty, with up to 10% choosing don't know across several categories. While they still viewed collaboration and communication as key (63% very important), they were less consistent in prioritizing competencies such as project management and knowledge sharing.

These findings suggest that students, particularly at bachelor and master levels, recognize that digitalization in construction is not only about tools and systems, but also requires strong interpersonal and adaptive skills. There was greater uncertainty among high school students, pointing to the need for earlier and more explicit development of such competencies in vocational education.

Open-ended responses

Students were invited to provide additional thoughts on digitalization in education. However, few relevant comments were received. One student noted that digitalization should be integrated into education, while another expressed dissatisfaction with digital meetings, hoping that this trend would not continue.

Results from Educator interviews

Integration of digital tools in teaching

Interviews revealed that digital tools are rarely integrated into teaching practices, despite their growing importance in the construction industry. Educators identified several reasons for this gap:

- Perceived irrelevance of digital tools in basic engineering topics, like mechanics statistics, and project management courses.
- Practical challenges, including software licensing and limited time for students to self-learn tools due to high academic workload.
- Curriculum limitations, which do not support a holistic approach to training in tools like BIM.
- Concerns about endorsing specific software, as students will encounter different tools in industry.

There is no dedicated course providing a comprehensive introduction to BIM and construction-specific digital tools. While bachelor's students receive some exposure to BIM, systematic training is limited at the master's level. As a result, students are expected to develop BIM skills independently, leading to a lack of hands-on experience and inconsistent integration of digital competency across courses.

Competence gaps and digital literacy among students

While students are comfortable using general-purpose tools such as PCs, Macs, and smartphones, educators observed gaps in foundational digital skills.

Students are characterized as "digital consumers", using tools without understanding underlying system logic, file structures, or digital workflows. Source evaluation, assessment of digital information and critical thinking remain key challenges, requiring substantial instruction.

Educators noted that AI tools like ChatGPT are widely used but often result in vague responses with poor citation practices, indicating a lack of critical engagement with AI-generated content.

However, educators see some improvements, such as students being more proficient in citation management and actively using platforms like YouTube and ChatGPT for self-learning, particularly in programming (e.g., Python).

Parametric Work and Advanced Digital Tools

Parametric workflows and data-driven design are recognized as crucial for the future of construction, yet they remain underrepresented in education. Educators emphasized the need for students to learn to work with BIM models at advanced levels, integrating dimensions like time (4D) and cost (5D), and gain practical experience with data visualization tools, such as dashboards, to manage information flows more effectively. These competencies are key for optimizing construction processes yet are not systematically taught.

Aligning Industry Needs with Digital Education

Regular dialogue with industry is essential for aligning educational curricula with industry needs. One interviewee highlighted the importance of industry feedback in identifying specific knowledge gaps among students. For example, one industry partner noted insufficient expertise in basic tools like Microsoft Word and Excel as a critical gap. Many students use LaTeX for producing text documents, and they are often unfamiliar with common document management systems widely used in the construction industry, such as Office 365.

Educators also stressed the importance of distinguishing between digital workflows and paperless workflows. Digital workflows involve data integration, automation, and collaboration, while paperless workflows merely eliminate physical documentation without fully leveraging digital tools.

A professor cited the National Museum project as an example of a digitalization disconnect. While promoted as a digital and paperless project, poor on-site infrastructure (e.g., lack of power and Wi-Fi connectivity) made BIM kiosks impractical, leading to a reliance on paper-based workflows instead. This highlights the gap between digital ambitions and practical implementation in real-world projects.

Student focus groups insights

Informal discussions with NTNU students revealed a gap between their expectations, educational emphasis on digital competencies, and industry demands. Across different year levels, students reported limited exposure to industry-relevant tools. First-year students were largely unaware of the digital skills needed in their careers, while older students acknowledged the importance of software but said formal training rarely went beyond basic tools like AutoCAD. Many assumed they would learn essential digital tools on the job rather than in their coursework.

Some questioned whether digital tools should be taught in university or left for professional practice, noting concerns that early reliance on software might undermine deeper theoretical understanding.

One striking theme was students' widespread use of generative AI tools, such as ChatGPT, despite minimal support or acknowledgment from educators. Without structured guidance, students use AI informally and independently, often without learning how to critically assess outputs. The lack of institutional recognition discourages open dialogue and may foster poor digital habits, such as uncritical reliance on AI and weak source evaluation.

Access to digital training was also inconsistent. While some students had programming experience (e.g., Python) or used Excel for data analysis, exposure to advanced workflows—such as BIM management, automation, or data-driven processes—varied widely.

A recurring point was that course structure heavily dictates student priorities, leaving little time for self-directed digital learning. Although many students expressed interest in developing digital skills, they felt constrained by workload, raising questions about whether digital competencies should be more explicitly embedded into existing coursework.

Discussion and result analysis

Bridging the Digital Skill Gap: Expectations vs. Reality

Despite high ambitions for digitalization among students and within educational curricula, the practical focus on developing digital literacy remains limited. Students recognize the importance of AI, drones, and BIM for their future roles but receive little structured training. Educators acknowledge the need for hands-on experience, yet digital skill development is inconsistent.

Expectations also vary by educational level. Master's students, with more industry exposure, show high confidence in tools like AI, BIM, and VR—100% expect increased use of AI. In contrast, high school students show greater uncertainty, especially regarding newer technologies, likely reflecting limited exposure. Confidence appears to follow familiarity, while lack of exposure results in hesitation, even for relevant tools.

Although BIM is essential in Construction 4.0 and 5.0 for data management and collaboration, interdisciplinary training remains largely scarce. Students focus mainly on hard skills, such as software use (Silwal & Safapour, 2024), often overlooking the integration of technical, human-centric, and conceptual abilities needed for navigating digital workflows.

AI-driven decision support tools are largely absent from formal education. Instead, students often use tools like ChatGPT informally for report writing and problem-solving, without structured guidance. The lack of recognition from educators undermines students' ability to develop critical AI literacy and safe, responsible usage habits.

To close this gap, introductory digital competency courses should be prioritized. These should not only present tools but also highlight their role in enhancing collaboration, efficiency, and innovation in modern construction processes.

Educational Priorities: Addressing Critical Skill Deficiencies

Although digital skills are formally recognized in educational frameworks, their definitions often lack clarity on the competencies needed for industry-specific applications. Skills in AI tools, advanced modelling, cybersecurity, and project management software are rarely addressed explicitly, revealing a gap between educational content and industry demands.

Educators highlight three critical digital competencies for future professionals: 1) The ability to critically assess and verify digital information, especially AI-generated content. As AI tools like ChatGPT become increasingly common, students require structured guidance to evaluate sources, avoid misinformation, and utilize digital tools responsibly. 2) A fundamental understanding of parametric workflows, rule-based systems used in BIM, simulations, and automated design. 3) Broader competence in data-driven workflows, such as predictive maintenance, real-time monitoring, and digital project planning, is a key to improving efficiency and sustainability.

While students acknowledge the value of programming and software skills, they often lack structured exposure to parametric design and data management. These areas require both theoretical grounding and hands-on experience to demonstrate how digital tools reduce errors and foster innovation.

These gaps align with findings from the ICILS survey, which indicate a decline in digital literacy among Norwegian students, suggesting that these challenges emerge even before higher education. The BCG report (2025) further highlights Norway's lag in AI adoption, citing a lack of structured upskilling as a key barrier. Without clearer educational priorities, these issues will likely persist, limiting the industry's ability to fully leverage AI and digital workflows.

Industry and Academia: Addressing the Mismatch

The construction industry increasingly values cross-disciplinary collaboration and integrated digital workflows. However, current educational structures often fail to reflect this shift. Limited integration between construction engineering, architecture, and building process programs restricts students' exposure to collaborative digital practices.

This gap leaves graduates underprepared. While some students expect to learn digital tools on the job, this is unreliable—larger firms may offer onboarding, but smaller companies often expect graduates to be job-ready. This places greater responsibility on educational institutions to ensure digital competence before graduation.

Stronger collaboration between academia and industry is needed to align curricula with practical needs. Regular industry input can help identify competency gaps, while exposing students to the software and workflows they will use professionally can facilitate a smoother transition into the workforce.

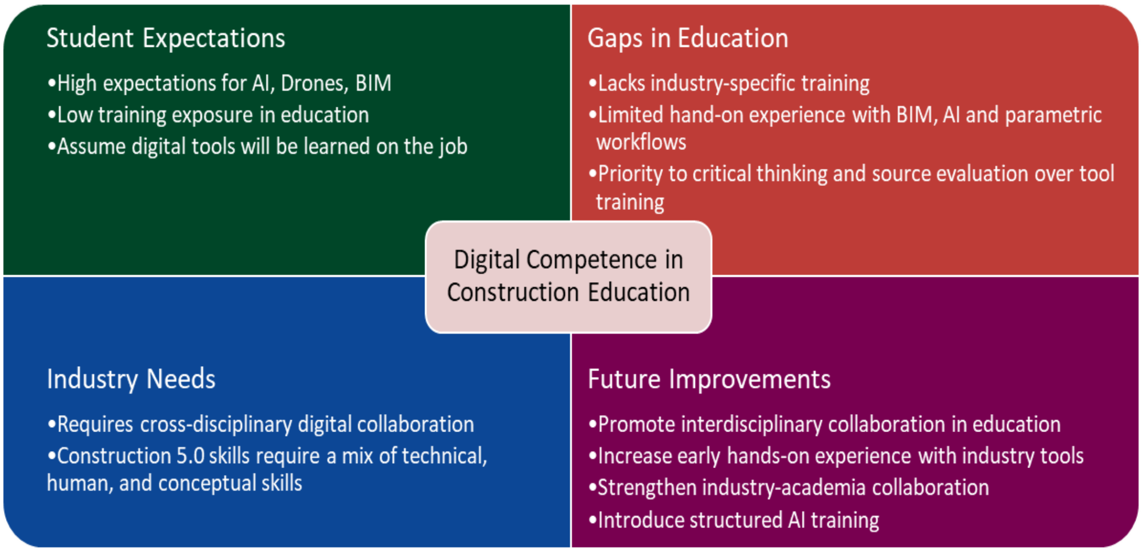

Figure 1: Digital Competence in Construction Education: Challenges and Opportunities

Shifting Digital Education Toward a Holistic Approach

To fully benefit from digitalization, construction education must integrate industry-relevant digital training rather than relying on post-graduation learning. Across all student groups, the belief that key skills, especially in AI, BIM, and smart tools, will be acquired after entering the workforce reflects a systemic gap in early digital competence development.

A shift is needed toward active digital problem-solving, emphasizing data-driven decision-making, collaboration, and adaptability. Structured AI training should be incorporated into curricula to prepare students for AI-integrated workflows, rather than leaving them to learn independently. Stronger ties with industry are also crucial to align expectations, tools, and skill development strategies. Early exposure to practical experience can help students recognize the relevance of digital tools. Currently, many receive limited real-world training in their first years. Making such experience mandatory earlier could strengthen understanding and motivation.

Finally, piloting interdisciplinary projects that bring together architecture, construction, and engineering students can simulate real-world collaboration and improve digital competence. Emphasizing hands-on and cross-disciplinary learning will better prepare students for the evolving demands of the digital workplace.

Conclusions

This study highlights a disconnect between student expectations, educational priorities, and industry needs in digital construction competencies. Figure 2 highlights the challenges and opportunities related to digital competence in construction education. While students recognize the growing importance of AI, BIM, and digital workflows, they receive limited structured training and often expect to acquire essential digital skills only after entering the workforce. This reliance on post-graduation learning reflects a systemic gap between education and practice and risks leaving some graduates underprepared for digitally integrated construction environments.

Findings also reveal apparent differences in expectations and confidence levels across educational stages, pointing to the need for more tailored approaches to digital skill development. Master's students appear digitally mature due to greater exposure, while high school students express more uncertainty, particularly regarding advanced tools. These patterns emphasize the importance of early and structured digital training, adapted to the learner's background and experience.

Educators recognize the value of digital competencies, such as critical thinking, parametric workflows and AI literacy, but face challenges due to curriculum limitations, resource constraints, and insufficient interdisciplinary collaboration. Addressing these issues will require a more holistic approach to digital education that balances technical instruction with human-centered capabilities.

While the scope of this study is limited, it was intentionally designed as an exploratory investigation within a socio-technical framework. This approach enabled the identification of early trends and challenges in preparing students for the digital construction sector. These findings lay the groundwork for future, more comprehensive studies and inform ongoing efforts to align construction education with the evolving demands of industry. Starting with the student's mindset, not only software skills, appears to be the most critical element for further utilization of digital solutions in the industry.

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