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ENHANCING ARCHITECTURAL LEARNING: INTEGRATING BUILDING TECHNOLOGY WITH INNOVATIVE PEDAGOGY

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Abstract
Architectural education is essential in shaping the future of the profession, and as technology evolves, integrating building technology into design studios becomes crucial. This study evaluates the integration of building technology within architectural design studio learning, with a focus on pedagogical effectiveness, curriculum alignment, and student engagement. Conducted within the Department of Architecture at Maulana Malik Ibrahim State Islamic University in Malang, the research involved 100 third-year undergraduate architecture students in a studio-based educational setting. Using a mixed-methods approach, including structured student surveys and literature-based benchmarking, the research assesses how well design studios incorporate technical knowledge, foster interactive learning, and support applied problem-solving. The findings reveal that while 62.6% of pedagogical components meet the desired benchmarks, significant gaps remain in the application of interactive and game-based learning methods. Collaborative learning scores were strong, ranging from 69.6% to 80.6%, but gamification and hands-on activities had low participation rates of 27% to 44.8%. Students showed solid analytical skills at 63.8% but struggled with innovative design, scoring only 59%. To improve the program, enhancements in experiential learning, course alignment with studio practice, and creative assessments are needed to better prepare graduates for modern architectural challenges.

Keywords: architectural pedagogy, curriculum design, educational innovation, studio learning framework

Introduction

Architectural education has traditionally centered on design theory, history, and aesthetics, often underemphasizing the technical competencies necessary for translating creative ideas into buildable realities. However, as the demands of the built environment evolve with increasing emphasis on sustainability, performance, and technological integration, architectural curricula must adapt accordingly. Design thinking offers a compelling framework to support this pedagogical transformation. Defined by Simon (1980) as a process of "satisficing" within ill-structured problems and later expanded by Schön (1983), design thinking is recognized as an iterative, reflective, and situated form of professional knowledge-in-action. Cross (2006) further established design as a unique epistemological domain, highlighting the cognitive strategies that distinguish design practitioners from other problem-solvers. These foundational texts establish a theoretical framework for understanding design thinking not just as a method but as a philosophy of learning and engagement. Within architectural education, this translates to a focus on processes such as empathy, ideation, rapid prototyping, and reflective practices that closely reflect the complexities of real-world design challenges. When thoughtfully integrated into studio pedagogy and curriculum design, design thinking can nurture not only creativity and innovation but also ethical awareness, resilience, and collaborative agency among students. Therefore, teaching students about building technology is essential for their future practice. Knowing different construction techniques, such as traditional, modular, or prefabricated, allows architects to choose the most appropriate design method (Razzouk & Shute, 2012). Understanding construction processes helps architects coordinate with contractors and ensure that design intent is realized during construction. Understanding structural systems (such as beams, columns, foundations, and configurations) ensures buildings' safety, stability, and integrity (Wang, 2021).

Givoni (1998) stated that architects must coordinate with structural engineers to integrate structural considerations seamlessly into their designs. Likewise, educational frameworks by Schön (1983) and Kolb (1984) emphasize experiential and reflective learning models that align with design studio culture, advocating for problem-based learning and feedback loops to foster deep understanding. Recent studies support these pedagogical shifts. For instance, Feng et al. (2024) highlight that building technology includes strategies for enhancing environmental performance, such as passive design techniques, energy-efficient systems, and sustainable building certifications. While Sari (2023) discusses how proficiency in digital tools enables architects to explore design alternatives, assess performance metrics, and communicate effectively with clients, consultants, and construction teams. To address this issue, contemporary architectural pedagogy is increasingly adopting interactive and innovative teaching methods, including problem-based learning, gamification, and blended learning models. These approaches have shown promise in enhancing student engagement, improving learning outcomes, and fostering a deeper connection between design thinking and technical performance.

This study examines how building technology is integrated into the design studio environment, specifically focusing on pedagogical strategies, curriculum coherence, and student learning outcomes. The objective is to evaluate the extent to which interactive and innovative methods are employed and to identify areas where studio-based learning can be made more effective. Recent studies support these pedagogical shifts. For instance, Sari (2023) highlights the role of digital tools in enabling design exploration and performance assessment. Furthermore, Memari et al. (2023) discuss how emerging technologies such as parametric modeling and digital fabrication are reshaping the skills demanded of graduates. Innovative methods such as gamification, blended learning, and studio integration of technology have demonstrated promise in enhancing student engagement, aligning with findings by (Feng et al., 2024) and (Schröpfer & Menz, 2019).

However, challenges remain in coherently embedding building technology within design curricula. Gaps persist in curriculum integration, assessment alignment, and ensuring that students are prepared for regulatory, environmental, and technical complexity in practice (Luck, 2019; Mueller et al., 2023). By analyzing student feedback and benchmarking current practices against recent pedagogical research, this study aims to offer practical insights into how architectural education can be restructured to better align with industry demands and educational best practices. To guide this investigation, the study is driven by the following research questions: (1) To what extent is building technology effectively integrated into design studio learning within the architectural curriculum? (2) What interactive and innovative teaching methods are currently implemented in studio-based architectural education, and how do students perceive their effectiveness? and (3) What are the key strengths and gaps in student learning outcomes related to the application of building technology in design processes? These questions inform the study's methodological approach, which combines quantitative student survey data with literature-based benchmarking to assess the alignment between curriculum objectives, teaching strategies, and student engagement in building technology education.

Literature Review

This review synthesizes current research on the integration of building technology in architectural education, the adoption of interactive and innovative pedagogical strategies, and the challenges of aligning theoretical knowledge with design practice. The review is structured around two interrelated themes: (1) Building Technology in Architectural Education and (2) Interactive and Innovative Learning Strategies. These themes provide the conceptual foundation for this study and establish the academic need for a more cohesive and practice-oriented approach to architectural technology education.

Building technology in architectural education

Building technology encompasses key domains such as structural systems, construction methods, material performance, sustainability strategies, and digital modeling tools like Building Information Modeling (BIM). As detailed in architectural technology by Anderson (2007), architectural design must synthesize aesthetic intent with technical precision to create buildings that are functional, durable, and environmentally responsible. The principles outlined by Kibert (2016) emphasize the integration of passive design strategies, material reuse, and energy efficiency as fundamental competencies. Legal and regulatory knowledge is essential for ensuring code compliance and understanding regulations.

Engel (2007) provides essential theoretical and practical frameworks for understanding how form, force, and material interact. These works form the intellectual backbone of a technologically informed design education. Studies by Allman & Leary (2024) emphasize that integrating education about building technology into architectural curricula is critical in preparing future architects for the diverse challenges of contemporary architectural practice. Educational institutions enable students to gain a deep understanding of designing safe, aesthetically pleasing, sustainable, and efficient structures by providing them with comprehensive knowledge and practical skills related to building technology (Gutierrez, 2014). This equips graduates with the necessary expertise to address the complexities of modern architectural projects and contribute positively to the overall built environment. Supporting research (Soroush et al., 2024; Zhu et al., 2023) confirms that integrating building technology into design studios enhances students' applied skills and conceptual understanding. Studies by Allman & Leary (2024) and Gutierrez (2014) emphasize the importance of a cohesive curriculum that bridges technical theory with design application. Moreover, the pedagogical emphasis on adaptive reuse, life-cycle design, and innovation (Mor & Mogilevsky, 2013) is increasingly reflected in international accreditation standards and industry expectations. By synthesizing foundational knowledge with real-world application, architectural education can produce graduates who are not only technically proficient but also visionary, ethical, and adaptable. This research thus explores how building technology can be more coherently embedded within design studio pedagogy to meet the evolving demands of professional practice.

Interactive and innovative learning strategies

Contemporary architecture programs are increasingly shifting toward active learning environments that promote student autonomy, collaboration, and problem-solving. Kolb (1984) has long emphasized the role of learner engagement, social interaction, and scaffolding in fostering meaningful understanding. These theories align closely with the design studio model, where learning unfolds through iterative processes, peer dialogue, and project-based tasks.

Problem-based learning (PBL), as described by Barrows & Tamblyn (1980), has proven effective in architecture and other design-oriented fields by emphasizing inquiry-driven, student-led investigation. A solid grasp of building technology enables architects to develop more innovative, efficient, and environmentally friendly designs (H. Samudro, 2020). Familiarity with building technology enhances communication and teamwork with engineers, contractors, and other stakeholders in the construction field. These methods have increasingly been adopted within architectural curricula to enhance cognitive retention, collaborative skills, and the capacity to address complex design challenges. While recent studies (Faraj Al-Suwaidi, 2023; McLaughlan & Chatterjee, 2020) offer empirical support for their impact, the pedagogical value of building technology integration remains under-examined. As Anderson (2007) argues, architectural graduates must be technically fluent in designing safe, efficient, and aesthetically compelling structures that respond to sustainability, functionality, and social equity imperatives. With the importance of the function of building technology and studio evaluation, this study aims to evaluate how building technology learning is applied in design studios in the Architecture Study Program of UIN Malang. This evaluation will involve collecting data on the use of building technology in the learning process, student perceptions and experiences, and the impacts produced on the quality of design studio learning. A growing body of educational research supports the use of structured evaluation frameworks to assess the effectiveness of teaching strategies in architecture. Empirical tools such as reflective journals, performance rubrics, and student surveys are increasingly used to generate actionable insights, as supported by recent research (Birer, 2022; Hettithanthri et al., 2023).

Methodology

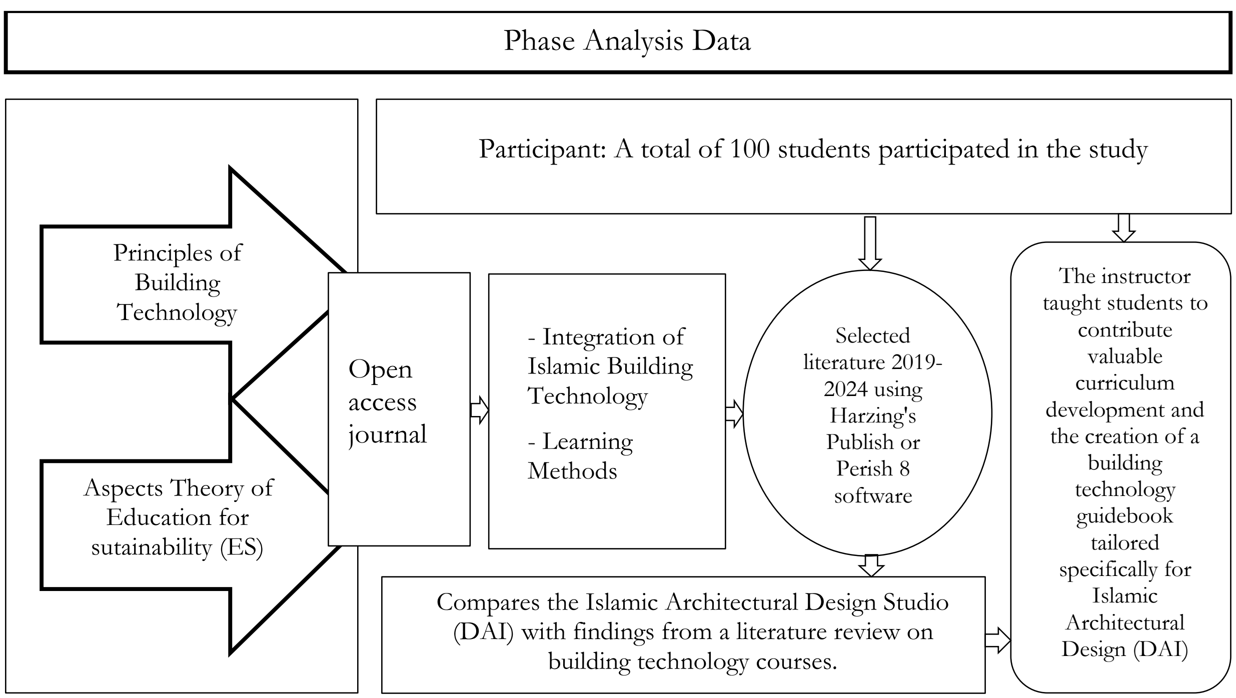
Research design and approach of the study

This study employs a mixed-methods research design, combining quantitative survey data with literature-based benchmarking to evaluate the integration of building technology into design studio learning. The goal is to assess the pedagogical effectiveness of current teaching strategies, the degree of alignment between curriculum and practice, and the extent to which interactive and innovative approaches are implemented. This analysis helps students and professionals make informed decisions when choosing the most efficient and cost-effective construction methods (Tolqunovna & Leonodovna, 2024). By examining each method's specific features and requirements, individuals can determine the most suitable approach for a given project, considering budget, time constraints, and complexity (Schröpfer & Menz, 2019). Focus on optimizing the use of building materials. Students learn to select materials that balance performance requirements with sustainability considerations (Ojo, 2024). The study is framed around three primary dimensions: The integration of building technology into studio-based learning, the use of interactive and innovative learning methods, and the evaluation of student learning outcomes related to applied problem-solving and design implementation.

Research site and participants

The literature review was guided by the definition of learning strategies as frameworks that enhance the quality and relevance of architectural education (Biggs & Tang, 2011; Kolb, 1984). In particular, the review focused on four central domains: Design Studio Learning, Student Understanding of Building Technology, Curriculum Development in Architectural Pedagogy, and Future Directions in Community-Oriented Design Education. To structure the literature selection and organization process, a review methodology was adopted following the guidelines of Booth et al. (2012), which emphasizes clarity in search design, source selection, and thematic synthesis. Primary data management was conducted using Mendeley Reference Manager, a tool that enabled the efficient categorization, annotation, and deduplication of sources across themes. To identify high-impact and thematically relevant articles, Harzing's Publish or Perish 8 software was employed. This software extracts and ranks citation data from interdisciplinary academic databases, including Google Scholar, CrossRef, and Scopus, providing valuable bibliometric insights for educational research in hybrid domains such as architecture, pedagogy, and digital learning. As shown in (Figure 1), selection criteria prioritized recent publications, encompassing the past 6 years from 2019 to 2024, to capture retrospective developments in architectural education processes.

Figure 1. *Research phase of essential analysis for the study*



The literature search, by focusing on key topics such as Implications for Design Studio Learning, Student Understanding, Curriculum Development, and Future Directions for Communities, aimed to comprehensively understand the essential aspects influencing architectural design studios' efficacy and sustainability.

Data collection and analysis

To investigate how historical architectural knowledge and virtual technologies influence students' learning experiences and conceptual understanding, this study utilized a quantitative survey-based methodology targeting undergraduate architecture students. A total of 100 students enrolled in the architecture study program at UIN Malang were selected as respondents. This sample size was determined based on representational needs across academic levels and is deemed sufficient to provide statistically meaningful results in social science research involving self-report instruments (Creswell, 2014). A structured questionnaire was developed to assess students' exposure to and perceptions of Historical architecture content in the curriculum, Use of digital and virtual technologies, and Integration of Islamic pedagogical values in building technology courses. Before distribution, the instrument was pilot-tested with a small subset of participants to ensure clarity, validity, and reliability. Feedback from this phase led to minor refinements in question-wording, scale sensitivity, and section instructions. Data were analyzed using descriptive statistics and comparative analysis, focusing on trends in student understanding and technological competence. The survey findings were then contextualized through comparison with prior literature on architectural heritage pedagogy (Faraj Al-Suwaidi, 2023) and virtual learning environments to frame the significance of observed learning outcomes.

A distinctive feature of UIN Malang's Architecture Study Program is the integration of *Maqasid Sharia* (the objectives of Islamic law) across the building technology curriculum. Each of the four Building Technology courses emphasizes a different aspect of this philosophical ethical framework: Building Technology 1 emphasizes *Hifz al-Mal* (Maintaining Property), with a student response citation volume of 35,313; Building Technology 2 integrates *Hifz al-Nasl* (Maintaining Descendants), cited 40,313 times; Building Technology 3 focuses on *Hifz al-'Aql* (Maintaining Reason), with 42,429 citations; Building Technology 4 returns to *Hifz al-Mal* (Maintaining Property), reflected in 19,600 citations. This curricular integration reflects a values-based approach to architectural education, embedding ethical, spiritual, and cultural dimensions into technical instruction. By combining Islamic epistemology with modern architectural pedagogy, the program fosters holistic competence among future architects who are technically proficient, ethically grounded, and socially responsible.

Results

Evaluation parameters in the building technology teaching and learning framework

Despite the increasing emphasis in prior literature on the need for interactive and innovative pedagogies in architectural education, particularly in the realm of building technology, many programs continue to approach technical subjects through passive, lecture-driven formats. This study seeks to address this gap by evaluating how design studio-based learning can integrate technological literacy through active pedagogical models that respond to both global developments and student needs. These findings are echoed in this research, which explores interactive and innovative learning as defined operationally in the following way: Interactive Learning is characterized by problem-solving, game-based strategies, and collaborative challenge-based activities where students actively engage with complex architectural scenarios. Innovative Learning involves self-directed inquiry, integration of digital tools, and the application of conceptual frameworks that allow for technological fluency and adaptive design thinking. Two key pedagogical tools were applied in this context: Technical Drawing Evaluation Grid (TDEG): This framework was employed to systematically assess students' acquisition of technical knowledge, skills, and representational competencies, providing a structured method for evaluating innovative learning outcomes. Problem-Based Learning (PBL): Used to implement interactive pedagogy, PBL situates students in realistic design challenges that require collaborative investigation and decision-making. In this study, PBL was further enhanced through game-based learning modules, increasing motivation and fostering deeper engagement with building technology content. Table 1 presents the Evaluation Criteria for the Interactive-Innovative Engineering Learning and Teaching Framework, which categorizes the key aspects of teaching and learning across three dimensions: Learning Methods, Learning Strategies, and Assessment Approaches. Each criterion is mapped to a specific pedagogical construct, such as site visits, sketching, collaborative learning, gamification, or peer assessment, and is designed to measure how well each component supports the development of both technical competencies and creative design thinking.

Table 1. *Evaluation criteria for the interactive-innovative engineering learning and teaching framework*

No	Subject			Aspects (TB1-4)	Question
1	Teaching & Learning Framework	Learning methods	Interactive	Technique	The DAI studio process applies engineering learning methods by visiting the site of the object to be designed (Site visit)
2					DAI studio process that applies engineering learning methods by honing sketching/drawing skills to express ideas visually (Classwork Drawing Activities)
3					The DAI studio process applies engineering learning methods by providing students with the opportunity to present information or design results in front of the class (Student Class Presentations)
4					DAI studio process that applies creative and fun engineering learning methods, such as games and interactive elements to increase student engagement, motivation, and understanding of the material being taught (Game-Based Learning (GBL))
5				Strategy	The DAI studio process applies strategic learning methods

			centered on students learning about a subject through the experience of solving complex and real problems (Problem-Based Learning); one example is the study of comparative study objects.
6			The DAI studio process applies strategic learning methods by creating reports/logbooks to reflect on achievements, successes, and shortcomings in assignments (Self-Reflecting Reports and Learning Diaries)
7			The DAI studio process applies strategic learning methods by working in groups to achieve specific learning objectives (Small group)
8		Evaluation	Assessment in the DAI studio by actively involving students in the evaluation process, such as quizzes, class debates, presentations and simulations, or role-playing
9	Innovative	Learning	DAI Studio combines face-to-face learning with online learning (Blended Learning)
10			DAI studio learning involves students studying course material at home through videos or readings, then using studio time for more interactive activities such as discussions, group projects, or problem-solving.
11			DAI Studio Learning uses game elements in the learning context to increase student motivation and engagement. This can include points, badges, leaderboards, and challenges (Gamification).
12			Assessment in the DAI studio involves students assessing the work or presentations of their classmates based on predetermined criteria (Peer Assessment).

13				Evaluation	Assessment in the DAI studio using game elements to assess student learning. For example, interactive quizzes through platforms such as Kahoot! or Quizizz (Game-Based Assessment)
14		Engineering field	Learning Approach	1. Variety of learning approaches 2. Development of thinking power 3. Development of knowledge 4. Psychomotor development 5.New technology 6. Development of interest 7. Feedback 8.Spatial visualization skills	Ability to process information logically, analytically, and creatively to achieve better understanding, solve problems, make informed decisions, and create innovative solutions within the DAI studio
15					Technology utilization skills encompass understanding, using, and employing technology effectively and efficiently within the DAI studio.
16					Applying engineering standards in the design process, from data search methods analysis to product design, using drawing standards that the study program or government has determined.

Evaluation of the implementation of building technology learning in dai studio

Data were taken from the results of filling out the questionnaire form by respondents who, in this case, are students who are currently/graduated DAI 5. Studio DAI 5 represents the evaluation of building technology because, according to the curriculum in the Architecture Study Program, UIN Malang, in the DAI 5 studio, students should have taken all Building Technology courses (Figure 2). Respondents are targeted at least 60% of all students who are currently/graduated DAI 5 in the same research period (2024). The following is the respondent data, along with the results of their answers

Figure 2. *Respondents' answer graph*

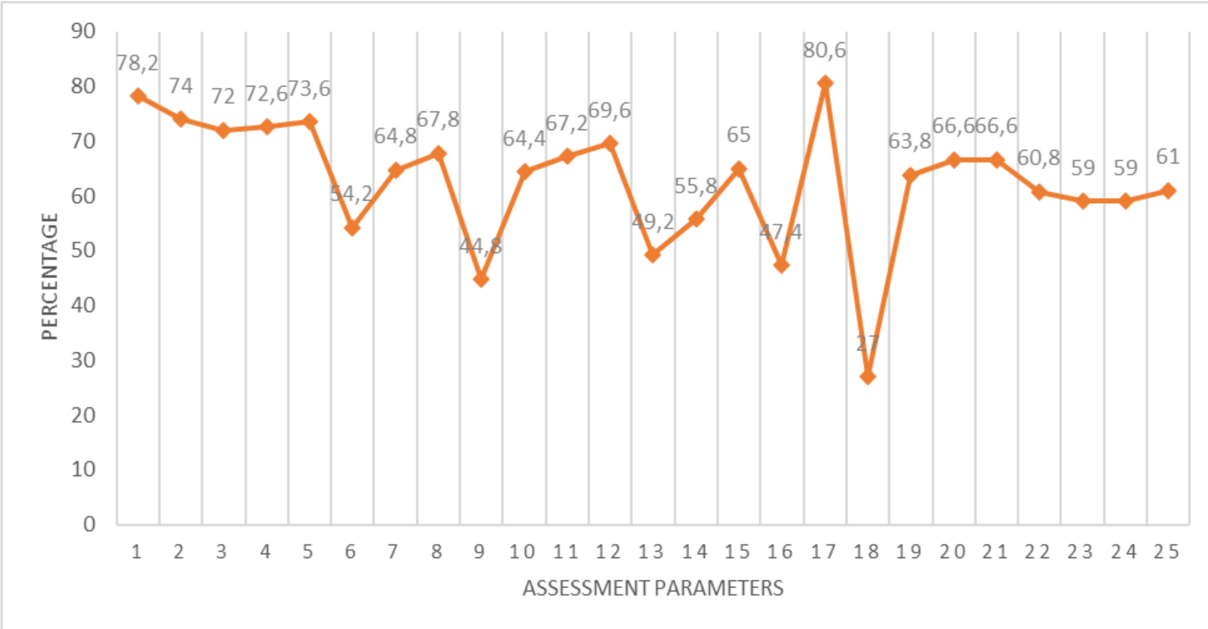


Table 2. *Results of questionnaire data analysis*

No	Assessment	Quantity	Percentage (Σrespondent points/Σmax points) x 100%
1	The materials and assignments in the Building Technology course can support design objects in the DAI studio.	391	78,2
2	Ability to implement designs in the DAI studio that consider energy use, such as climate response, energy conservation, or energy efficiency	370	74
3	Knowledge and understanding of economic aspects such as proper use of materials, construction sustainability, and maintenance efficiency in DAI studio designs	360	72
4	The design objects in the DAI studio pay attention to local aspects, the surrounding environment, the sustainability of civilization, and good building performance	363	72,6
5	Able to analyze and create ideas from appropriate and correct data sources into design objects in the DAI studio.	368	73,6
6	The DAI studio process applies engineering learning methods by visiting the site of the object to be designed (Site visit)	271	54,2
7	DAI studio process that applies engineering learning methods by honing sketching/drawing skills to express ideas visually (Classwork Drawing Activities)	324	64,8

8	The DAI studio process applies engineering learning methods by allowing students to present information or design results in front of the class (Student Class Presentations).	339	67,8
9	DAI studio process that applies creative and fun engineering learning methods such as games and interactive elements to increase student engagement, motivation, and understanding of the material being taught (Game-Based Learning (GBL))	224	44,8
10	The DAI studio process applies strategic learning methods centered on students learning about a subject through the experience of solving complex and real problems (Problem-Based Learning); one example is the study of comparative study objects.	322	64,4
11	The DAI studio process applies strategic learning methods by creating reports/logbooks to reflect on achievements, successes, and shortcomings in assignments (Self-Reflecting Reports and Learning Diaries)	336	67,2
12	The DAI studio process applies strategic learning methods by working in groups to achieve specific learning objectives (Small group)	348	69,6
13	Assessment in the DAI studio by actively involving students in the evaluation process, such as quizzes, class debates, presentations, simulations, or role-playing.	246	49,2
14	DAI Studio combines face-to-face learning with online learning (Blended Learning)	279	55,8
15	DAI studio learning involves students studying course material at home through videos or readings, then using studio time for more interactive activities such as discussions, group projects, or problem-solving.	325	65
16	DAI Studio Learning uses game elements in the learning context to increase student motivation and engagement. This can include points, badges, leaderboards, and challenges (Gamification).	237	47,4
17	Assessment in the DAI studio is done by assessing the work or presentations of their classmates based on predetermined criteria (Peer Assessment).	403	80,6
18	Assessment in the DAI studio using game elements to assess student learning. For example, interactive quizzes through platforms such as Kahoot! or Quizizz (Game-Based Assessment)	135	27
19	Ability to process information logically, analytically, and creatively to achieve better understanding, solve problems, make informed decisions, and create innovative solutions within the DAI studio	319	63,8
20	Technology utilization skills include understanding, using, and utilizing technology effectively and efficiently within the DAI studio.	333	66,6
21	Applying engineering standards in the design process, from data search methods analysis to product design, using drawing standards determined by the study program or government.	333	66,6
22	The ability to implement designs in the DAI studio that considers the principle of *hifdz al-mal* (protecting and preserving wealth) is	304	60,8

	based on the benefits and effectiveness of using building materials, energy, time, and financing.		
23	The ability to implement designs in the DAI studio that considers the principle of *hifdz an nasl* (preserving descendants/civilization) through local cultural preservation practices that do not conflict with Islamic values.	295	59
24	The ability to implement designs in the DAI studio that considers the principle of *hifdz al aql* (maintaining, preserving, and developing the health and intelligence of the mind) to process information logically, analytically, and creatively to produce various forms of benefits and reject various damages/badness, starting from the design process to the final result.	295	59
25	Implementing designs in the DAI studio that consider the principle of *hifdz al-mal* (protecting Property) through building designs and concepts that respect private and public property rights.	305	61
	Total Value	**7.825**	**62,6**

The evaluation results of implementing Building Technology learning in the Islamic Architecture Design (DAI) studio at the Architecture Study Program at UIN Malang can be seen from the respondent answer table (table 1), then calculated using the formula above. For evaluation, per question-answer/parameter, the implementation of Building Technology learning in the Islamic Architecture Design (DAI) studio is said to be successful if it has a minimum value of 300 points. From the respondents' answer table (Table 2), it is known that out of 25 parameters, 8 parameters have low values below 300 points or below 60% success. Then, there is 1 parameter with the highest value above 400 points or reaching 80% success. The rest, namely 16 other parameters, have an average value of 300-400 points, or 60%-80% are declared successful.

For evaluation, the overall answers/parameters from the respondents' answer table (Table 2) above show that the total value is 7,825 points or 62.6% of the highest 12,500 points. Based on the calculation above, the implementation of Building Technology learning in the Islamic Architecture Design (DAI) studio can be declared "ENOUGH", which has a Sufficient Implementation value (4,168 - 8,334). The "sufficient" result is certainly not the maximum result; it must be continuously improved, at least reaching the lower threshold value for good implementation (8,335 – 12,500), considering the importance of the function of the Building Technology course as a support for the DAI studio. The following parameters need to be improved immediately, with values below the successful implementation.

Discussion

The research compares the Islamic Architectural Design Studio (DAI) with findings from a literature review on building technology courses. The goal is to understand the implications of integrating building technology into design studio learning at the UIN Malang Architecture Study Program. This comparison will assess the application of building technology learning within the Islamic Architecture Design (DAI) studio. Insights gained from the questionnaire responses of students, lecturers, and other stakeholders will further illuminate the understanding and application of this learning approach. Ultimately, the research outcomes will contribute valuable to curriculum development and the creation of a building technology guidebook tailored specifically for Islamic Architectural Design (DAI). This endeavor aims to enhance educational practices and better prepare students to integrate technological advancements effectively into their architectural designs at UIN Malang.

Implications for design studio learning

Alghamdi et al. (2023) and Karimi & Farivarsadri (2024) underscore that integrating building technology into the Islamic Architectural Design Studio (DAI) curriculum enhances students' ability to apply theoretical knowledge in practical contexts. By incorporating sustainable building materials and contemporary construction techniques, students can develop comprehensive design solutions that uphold Islamic architectural values while aligning with modern technological demands. Integrating building technology into the Islamic Architectural Design Studio (DAI) curriculum represents a transformative opportunity for students to bridge theoretical knowledge with practical application (Nawawi et al., 2024).

Nawawi et al. (2024) highlight the transformative potential of this integration in bridging theoretical learning with real-world application. Further supporting this view, Kıdık & Asiliskender (2024) and Nawawi et al. (2024) emphasize that such curricular innovations enable students to comprehend the core principles of Islamic architecture and effectively implement them using advanced building technologies. Rodriguez et al. (2024) and Saxena & Arora (2024) point out that using sustainable materials allows students to design in ways that reflect Islamic aesthetics while embracing environmental responsibility. By analyzing the ecological properties of materials such as adobe, timber, and recycled components, students are encouraged to make sustainable choices, thus reinforcing environmentally conscious design thinking.

Moreover, integrating modern construction techniques empowers students to tackle complex design challenges effectively. This includes leveraging digital tools such as Building Information Modeling (BIM) to simulate construction processes and optimize building performance (Temel & Polatoglu, 2024). Learning to integrate structural systems and advanced building technologies seamlessly into their designs can help students create innovative solutions that enhance both functionality and aesthetic appeal (G. Samudro et al., 2024). Through this holistic approach, students understand how building technology enhances the practical realization of their design concepts (Ezz & Elsayed, 2024; Shehata, 2024). They learn to navigate the intersection of tradition and innovation, synthesizing historical precedents with contemporary demands for efficiency, durability, and environmental stewardship (Canakcioglu et al., 2023). Integrating building technology into the Islamic Architectural Design Studio (DAI) curriculum equips students with the skills and knowledge necessary to become adept architects who can effectively respond to the complexities of modern architectural practice. It prepares them to contribute meaningfully to the built environment by designing sustainable, culturally resonant spaces that embody Islamic architectural heritage and cutting-edge technological advancements. Overall, integrating building technology into the Islamic architecture studio empowers students with essential competencies to tackle contemporary architectural challenges. It fosters the development of sustainable, culturally attuned, and technologically sophisticated environments that embody both Islamic heritage and modern advancements.

Student understanding

Akay & Akay (2023), Khalili (2023), and Küçük & Aksu (2023) report varying levels of understanding among students, lecturers, and stakeholders regarding the integration of building technology within the framework of Islamic architectural design. This variation highlights the urgent need for educational initiatives specifically designed to bridge these knowledge gaps. The implementation of such targeted programs is critical to achieving a comprehensive grasp and consistent application of building technology principles across architectural education and practice.

Curriculum development

De Luca et al. (2024) and Tarolli & Józefowicz (2023) emphasize the necessity of equipping architecture students with practical tools that reflect both technological advancements and cultural contexts. Based on these insights, a clear opportunity emerges to develop a specialized building technology guidebook tailored to the Islamic Architectural Design context. Such a guidebook would align curriculum content with current industry standards and technological innovations, thereby enhancing the practical relevance and professional competitiveness of graduates from the UIN Malang Architecture Study Program. Davis (2017) and Yuan et al. (2023) highlight the importance of including updated content on building materials, sustainable construction practices, and digital tools within architectural training resources. In response, the proposed guidebook should include comprehensive sections on these topics and be supported with illustrative case studies that demonstrate the successful integration of building technology into Islamic architectural design. These examples would provide students with tangible, real-world applications of theoretical principles.

Erkarslan & Akgün (2022) and Peimani & Kamalipour (2022) advocate for collaborative curriculum development involving stakeholders from academia, industry, and alumni networks. Their recommendations reinforce the importance of co-developing the guidebook with practicing professionals and field experts. This ensures that the content remains relevant, up-to-date, and responsive to evolving industry demands. Hettithanthri et al. (2023) and Tang & Porter-Voss (2023) support this strategy, emphasizing the value of industry-informed educational materials in enhancing student readiness for professional challenges. Finally, Tarboush & Gürdallı (2022) argue for curriculum revision grounded in evidence-based tools and frameworks. Aligning the Islamic Architectural Design Studio (DAI) curriculum with the proposed guidebook would strengthen the link between academic learning and professional practice, thereby better preparing students to meet real-world demands and making them more competitive in the architectural labor market.

Future directions

Puente (2021) and Tsigkas (2024) stress the importance of continuous collaboration among educators, practitioners, and policymakers for the sustainable integration of building technology into Islamic Architectural Design (DAI) studio learning. Such collaboration supports iterative curriculum refinement, ensuring that students are equipped not only with traditional design principles but also with the technical competencies needed to address contemporary architectural challenges. By maintaining an open line of communication, educators can stay informed about the latest advancements and trends in building technology (Birer, 2022). Practitioners who bring hands-on industry experience can provide valuable insights into the practical application of these technologies in real-world scenarios (Briskin & Land, 2020; Chan, 2020; Remillard & Kim, 2020). Policymakers can offer a broader perspective on regulatory and policy frameworks that impact architectural practices (Calikusu et al., 2022).

To institutionalize this collaboration, Heylighen et al. (2021) and Shuman (2022) recommend organizing recurring forums such as workshops, seminars, and roundtable discussions. These platforms foster knowledge exchange among stakeholders and encourage reflection on pedagogical strategies, emerging technologies, and the evolving architectural landscape. As Mohamed (2020) demonstrates, educators benefit from showcasing their research and pedagogical innovations, while practitioners enrich these discussions with applied case studies. Simultaneously, policymakers can contribute by outlining current and upcoming regulatory changes, ensuring curricular alignment with national development goals and industry expectations.

Such collaboration will support the ongoing curriculum refinement, ensuring it remains relevant and up-to-date (Anindita et al., 2022). It will also help to balance the teaching of traditional design knowledge with the integration of modern technical skills. As a result, graduates will be equipped with a well-rounded education that enables them to address contemporary architectural challenges effectively (Lancho Alvarado, 2020). For instance, integrating real-world projects and internships into the curriculum can give students hands-on experience and exposure to current industry practices (Ramlall et al., 2022; Sharma et al., 2021). This practical training, combined with theoretical knowledge, will prepare students to navigate the complexities of modern architectural design and construction (Deamer, 2020; El-Wakeel, 2020). Moreover, this collaborative approach can lead to joint research initiatives and innovation projects. Educators, practitioners, and policymakers can contribute to advancing building technology and its application in Islamic architectural design by working together. These collaborative projects can also allow students to engage in cutting-edge research and innovation, enhancing their learning experience and professional development (McLaughlan & Chatterjee, 2020).

Conclusion and Implications

This study aimed to investigate the integration of building technology into architectural design studio learning and to assess the effectiveness of current pedagogical practices within the architectural curriculum. The findings indicate that building technology integration in design studio learning varies. Successful integration occurs when instructors align technology with studio projects, but many instances remain superficial, limited to appendices or post-design rationalizations. Innovative teaching methods, like collaborative workshops and digital modeling tools, were highlighted, with students favoring experiential learning that directly applies building technology principles. However, time constraints, varied instructor familiarity, and differing student readiness often hindered effectiveness. While students improved their understanding of material performance and constructability with integrated technology, they struggled to apply these principles independently, indicating a need for better curriculum scaffolding. The study emphasizes that effective integration requires intentional pedagogical design, interdisciplinary collaboration, and ongoing alignment between theory and practice, as current interactive methods show uneven impact without systemic curricular support.. Future architectural education should aim to foster deeper synthesis of technical and creative competencies, ensuring that students graduate with both conceptual and practical mastery. These findings not only highlight areas for improvement in current educational practice but also offer a foundation for rethinking how building technology is taught to enhance its relevance, accessibility, and long-term impact on student learning and professional readiness.

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