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A Blockchain-Based Framework: Enhancing Authorship and Academic Integrity in Architectural Design Education

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Abstract

Architectural design education faces increasing challenges in verifying authorship and preventing plagiarism, particularly with the rise of digital tools such as BIM and CAD. Traditional plagiarism detection systems are inadequate for visual and process-based outputs, making originality difficult to authenticate. This study adopts a Design-Based Research (DBR) approach to conceptualise two blockchain-enabled frameworks tailored for architectural education: 1) the Blockchain-Based Product Collection, which archives and verifies student submissions across semesters, and 2) the Blockchain-Connected BIM, which logs design process data through command histories on a blockchain ledger. Both systems aim to enhance transparency, traceability, and multi-lecturer supervision while fostering academic integrity. Unlike existing models that focus solely on credentialing or post-submission validation, these framework embed authorship protection throughout the design process. The study provides a theoretical foundation for future prototype development and encourages interdisciplinary collaboration to realise a scalable, ethically grounded solution for design education. By securing both the outcome and the process, these frameworks offer a new paradigm for fostering creativity, accountability, and originality in the digital studio environment.

Keywords: Academic integrity, architectural education, authorship, blockchain, NFT, plagiarism

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Rangka Kerja Berasaskan Blockchain: Memperkasakan Hak Cipta Dan Integriti Akademik Dalam Pendidikan Reka Bentuk Seni Bina

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Abstrak

Pendidikan reka bentuk seni bina kini berdepan dengan cabaran besar dalam mengesahkan hak cipta dan mencegah plagiat, terutamanya dengan peningkatan penggunaan alat digital seperti BIM dan CAD. Sistem pengesanan plagiat tradisional tidak sesuai untuk menilai hasil kerja visual dan berasaskan proses, menjadikan keaslian hasil kerja sukar untuk dibuktikan. Kajian ini menggunakan pendekatan Design-Based Research (DBR) untuk mencadangkan dua rangka kerja berasaskan blockchain yang disesuaikan untuk pendidikan seni bina: 1) Blockchain-Based Product Collection, yang mengarkib dan mengesahkan penyerahan pelajar dan 2) the Blockchain-Connected BIM, yang merekodkan data proses reka bentuk melalui sejarah arahan dalam lejar blockchain. kedua-dua sistem ini bertujuan meningkatkan ketelusan, kebolehkesanan dan penyeliaan berbilang pensyarah sambil menggalakkan integrity akademik. Tidak seperti model sedia ada yang hanya menumpu kepada pengesahan selepas penyerahan, rangka kerja ini melindungi hak cipta sepanjang keseluruhan proses reka bentuk. Kajian ini menyediakan asas teori untuk merealisasikan penyelesaian yang boleh diskala dan beretika dalam pendidikan reka bentuk. Dengan melindungi hasil dan proses, rangka kerja ini menawarkan paradigma baharu untuk memupuk kreativiti, akauntabiliti dan keaslian dalam persekitaran studio digital.

Kata Kunci: *Hak cipta, integriti akademik, pendidikan senibina, plagiat, blockchain, NFT*

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1.0 Introduction

Architectural design education is a discipline that heavily relies on creative expression, originality, and intellectual property. Unlike textual plagiarism, which can be detected through existing software, plagiarism in architectural design presents unique challenges due to the subjective nature of design interpretation and the ease of digital replication (Wojtkun, 2022). With the widespread use of digital tools in architecture education, students can effortlessly duplicate and manipulate design elements, making it increasingly difficult to verify the authenticity of their work. This issue threatens not only academic integrity but also the professional credibility of emerging architects (Mostafa, 2011).

Furthermore, academic institutions face difficulties ensuring the authenticity of students' design submissions, as conventional plagiarism detection systems are inadequate for architectural works. The traditional process of design evaluation often lacks the necessary transparency and traceability, leaving room for disputes over originality. Without a reliable method for authenticating design ownership, students may face challenges in proving their intellectual contributions, leading to ethical concerns in academia and the professional field (Dich et al., 2013; Li et al., 2023). Additionally, (Coorey, 2018) emphasises the need for design education to move beyond simply detecting plagiarism and instead cultivate creativity and originality in students through structured processes and reflective exercises.

Amidst these challenges, Blockchain technology has emerged as a promising solution due to its inherent characteristics: decentralisation, immutability, transparency, and chronological traceability. These features offer a novel way to address the authentication, authorship, and credibility challenges in design education. Recent studies have explored blockchain in various educational and creative domains, demonstrating its ability to issue tamper-proof certificates, support decentralised assessment systems, and maintain verifiable records of ownership (Elmessiry et al., 2021; Pfeiffer et al., 2022; Zhang et al., 2020). However, most of these studies remain fragmented or limited to specific features such as reward systems or credentialing. There remains a lack of discipline-specific, pedagogically grounded frameworks that fully integrate blockchain into the complex studio workflows of architectural education.

To bridge this gap, this study adopts a Design-Based Research (DBR) approach to propose an integrated, conceptual solution tailored to architecture design pedagogy. Rather than evaluating an existing tool, this study begins by identifying a pressing pedagogical problem, which is the lack of reliable systems for verifying the originality and authorship of student design work, and offers a theoretical model to address it. This paper introduces two interrelated system concepts: 1) Blockchain-Based Product Collection and 2) Blockchain-Connected BIM. These frameworks aim to embed integrity, authorship, and academic trust into the heart of design studio education by leveraging blockchain as a tool not only for security, but for enhancing pedagogical transparency. This study provides the theoretical foundation for future implementation and invites interdisciplinary collaboration between design educators, technologist, and policy-makers.

2.0 Literature Review

2.1 Plagiarism in Architectural Education

Plagiarism in architecture education is notably more difficult to define and detect than in text-based disciplines, primarily due to the visual and interpretive nature of architectural output. Student projects, ranging from hand-drawn to complex 3D BIM models, are highly susceptible to duplication, manipulation, and appropriation without leaving clear traces of misconduct. Prashar et al. (2024) argue that plagiarism in architecture is not always deliberate; students often operate in a grey zone between imitation and originality, compounded by institutional gaps in ethical training and authorship awareness. The emphasis on inspiration in studio culture can blur the line between intellectual borrowing and unethical reuse.

Wojtkun (2022) adds a legal dimension to this discussion by highlighting the limits of copyright enforcement in architectural design. Given the abstract and stylistic similarities that can naturally occur in design, legal frameworks struggle to determine infringement based on visual similarity. Wojtkun emphasises that educators must do more to instil a clear understanding of authorship boundaries, especially as digital technologies and generative AI tools become ubiquitous in design workflows.

The legal landscape of architectural copyright further complicates authorship claims. Greenstreet (2019) discusses how U.S. legal reforms such as the Architectural Works Copyright Protection Act (AWCPA) have attempted to define originality in built form, but often fail to accommodate the creative fluidity of architectural practice. The misuse of copyright as a defensive or even predatory tool, especially through legal “trolling”, creates additional barriers for young designers trying to understand ownership rights. Landmark like Zalewski v. Cicero Builder and Sturdza v. UAE demonstrate the ambiguity and contested definition of architectural authorship and its protection under law.

Fathoni (2023) introduces a contemporary angle by discussing how generative AI tools, such as DALL-E or Midjourney, raise new concerns about originality in student design. These tools, while fostering creativity, also pose risk of shortcutting the design process, allowing students to generate “original” visuals with minimum effort. The lack of transparent documentation in the use of such tools complicates both evaluation and authorship verification, necessitating clearer academic policies and technological safeguards. Controlled integration of AI, as Fathoni suggests, may help promote integrity if embedded with ethics-driven usage protocols.

Pedagogical practices also contribute to this complexity. Harry et al. (2025) critique the shift away from traditional master-apprentice pedagogies in architecture studios, which historically emphasised reflective learning and mentor-guided design development. They highlight that the erosion of atelier-style training has been accelerated by the transition to

virtual design environments and digitally mediated studios. While these platforms expand access and flexibility, they risk weakening the embodied, experiential learning that is essential for cultivating design ethics and authorship awareness. Harry et al. further argue that this shift fosters outcome-focused teaching environments where plagiarism may go unnoticed or unchallenged. Reinforcing guided reflection, design intent documentation, and process accountability, they suggest, is crucial to promoting ethical behaviour in architectural education.

Recent advancements in plagiarism detection are beginning to tackle visual domains, including hybrid approaches that integrate blockchain and AI. Prihatno et al. (2023) propose a novel AI-driven plagiarism detection system that combines image recognition with NFT-backed ownership verification. Their EfficientNet-powered neural network checks for image similarities across blockchain-registered design assets, representing a potential breakthrough in tracing visual plagiarism at scale. While such systems are still emerging, they illustrate a growing acknowledgement of the need for visual plagiarism tools tailored to design education.

Taken together, these previous studies suggest that combating plagiarism in architectural education demands more than surveillance or penalties. It requires a systematic redesign of how creativity, authorship, and assessment is structured. A blockchain-enabled design tracking system, combined with ethical training and AI verification tools, could offer a much-needed foundation for fostering originality and safeguarding intellectual property in architectural pedagogy.

2.2 Blockchain Technology in Education

Blockchain technology has emerged as a transformative solution in education, particularly for addressing issues related to data authenticity, academic integrity, authorship, and learner ownership. Its decentralised and immutable structure makes it uniquely suited for managing academic records, verifying credentials, and preserving the originality of student work. According to Li (2024), the integration of blockchain into ideological and academic systems enhances trust, traceability, and long-term record integrity within higher education, especially when combined with frameworks like Deep Belief Networks for learning analytics.

The issuance and validation of academic certificates remain one of the earliest and most impactful uses of blockchain. Institutions such as MIT and the University of Nicosia pioneered blockchain-based diplomas that offer tamper-proof, verifiable credentials (Sharples & Domingue, 2016). Expanding on this, Vaezinejad et al. (2024) stress that blockchain also enhances feedback loops, digital credentialing, and peer verification processes in higher education ecosystems.

In design education specifically, Non-Fungible Tokens (NFTs) have been proposed as a tool for tracking ownership and originality in creative outputs. Prashar et al. (2024) argue that NFTs can embed metadata like timestamps and creator ID into digital design submissions, enabling clearer authorship attribution and dispute resolution mechanisms. This is particularly relevant for architecture, where originality often manifests in visual or model-based formats.

From a systems architecture perspective, Meng (2024) introduces the concept of a blockchain-based learning credit chain. Originally applied to track faculty development, the model can be extended to student portfolios by integrating smart contracts and clustering algorithms to assess individual performance trends securely.

Beyond credentialing, blockchain is being explored to enhance sustainable education and transparency. Ariffin et al. (2025) propose that blockchain's strengths, immutability, decentralisation, and auditability can foster sustainable educational practices, including secure digital evaluations, accreditation, and global data exchange standards. However, they also caution that technical, ethical, and organisational challenges must be addressed to achieve full adoption.

Cheng (2024) adds that for blockchain to effectively support learning environments, the platforms must be designed with clear user experience layers and access controls, ensuring interoperability with existing learning management systems and protecting student privacy in accordance with educational regulations.

As a result, the current literature increasingly recognises that blockchain's educational potential lies not only in securing final academic products but in restructuring how learning is documented, validated, and verified over time. Whether through NFT-tracked design submissions, decentralised learning ledgers, or cross-institutional credentialing systems, blockchain provides a robust infrastructure to support ethical, transparent, and learner-centred education, particularly in creative disciplines like architecture and design.

2.3 Blockchain and NFT Applications in Design Education

The unique demands of architectural education, which are iterative design processes, visual outputs, and collaborative studio environments, make it a strong candidate for blockchain-enabled reform. Yet, comprehensive frameworks directly applying blockchain or NFTs to architectural pedagogy remain limited.

Pfeiffer et al. (2022) introduced a model where NFTs are issued for modular academic achievements, validated by multiple instructors. This is especially relevant in architectural education, where assessments span multiple stages and involve several reviewers. NFT-based modular credentials could provide immutable records of student progression and clearly trace individual contributions in collaborative studio settings.

Regner et al. (2019) designed a prototype NFT ticketing system using Design Science Research (DSR), which, although outside education, offers a transferable logic for architectural workflows. Their framework suggests how design outputs might be tokenized with access control, provenance metadata, and timestamp logs, mechanisms essential to protecting both process and authorship.

Building on this, Cheng (2024) and Meng (2024) advocate that NFTs serve as verifiable units of creative ownership in academic and industrial design. Their application of NFTs in student portfolios offers compelling evidence of how blockchain can securely authenticate and timestamp creative work, ensuring transparency and authorship attribution even in collaborative settings.

Rao & Peng (2025) further propose a blockchain-based resource integration platform that supports interdisciplinary design education. Their model applies smart contracts and distributed ledgers to reduce sharing costs, enhance copyright protection, and automate authorship validation across collaborative projects, all highly transferable to architectural studios.

Similarly, Chun (2024) highlights the relevance of tokenization in project-based learning environments, arguing that NFTs not only preserve original work but also support the evaluation of student creativity through immutable, peer-validated ledgers.

Darabseh & Martins (2023) directly address the architectural sector, proposing blockchain-based tokenization of building designs to monitor intellectual property and modifications. This is echoed by Mourtzis et al. (2023), who demonstrate how digital twins and blockchain can co-function to secure design data in complex manufacturing, a parallel with CAD/BIM environments in architectural education.

Vaezinejad et al. (2024) argue that the visual-centric nature of design makes traditional text-based plagiarism detection inadequate. Integrating NFTs with AI visual detection systems, such as those proposed by Prihatno et al. (2023), would allow studios to automate the verification of originality across submission cycles.

Harry et al. (2025) add a pedagogical dimension, suggesting that blockchain may restore process-based learning by providing a longitudinal record of student design iterations, fostering reflection and design ethics, both often diminished in digitised studio culture.

Despite these advances, what remains lacking is a unified pedagogical framework that links blockchain technologies directly to architectural design studio models. This study responds to that gap by proposing a system that not only authenticates outputs but embeds blockchain into the design process itself, preserving iteration history, reinforcing authorship, and supporting transparent multi-instructor supervision

3.0 Methods

This study adopts a Design-Based Research (DBR) approach to conceptualise innovative frameworks that address critical gaps in authorship verification, process traceability, and academic integrity within architectural design education. DBR is particularly well-suited for educational innovation where theory-driven design interventions are needed to solve real-world problems (McKenney & Reeves, 2018; Reeves, 2006). It emphasises iterative development, stakeholder involvement, contextual relevance, and theoretical grounding, making it ideal for this blockchain-integrated studio pedagogy.

The study follows the intial phases of DBR – problem identification. theoretical exploration, and prototype design. The later phases (prototype testing and refinement) are reserved for future development.

3.1 Problem Identification through Studio Observation and Teaching Experience

The first phase involved identifying pedagogical problems through reflective teaching practice and informal observation in architecture studio environments. Key issues identified included:

- The absence of a secure system to verify the authenticity and authorship of student submissions;
- The ease of duplicating digital design work, particularly in BIM and CAD platforms, across different studio groups.
- Limited supervisory visibility in large or parallel studio settings, where multiple instructors assess student work independently;
- The lack of a process-oriented archive to document and review the evolution of student ideas over time

These insights emerged from recurring teaching experiences and anecdotal cases where duplicated student submissions went undetected. These phases laid the groundwork for practical studio challenges.

3.2 Theoretical and Technological Review

A literature review was conducted to investigate the potential of blockchain and NFTs in similar educational and professional contexts. Key technologies and frameworks from prior research were critically examined to inform the design architecture of the system proposed in this study. The literature review focuses on four domains:

- Blockchain in education – where studies show its use in credentialing, feedback tracking, and secure learning records (Turkanović et al., 2018);

- NFTs in digital authorship – used to assert ownership in visual domains such as art and gaming (Mani et al., n.d.; Rehman et al., 2021);
- Plagiarism detection systems – including image-based detection using deep learning (Prihatno et al., 2023);
- Studio Pedagogy – emphasising ethical design practices, creative iteration, and fair assessment (Mostafa, 2011)

Technological models such as EduCTX(Turkanović et al., 2018), NFT-STIS (Elmessiry et al., 2021) and blockchain-based credential systems Sharples & Domingue (2016), alongside more recent developments by Ariffin et al. (2025) and Vaezinejad et al. (2024), were examined to extract relevant mechanisms such as timestamping, smart contracts, layered access, and decentralised validation. These insights informed the conceptual logic and structure of the proposed frameworks, particularly in their application to authorship verification and iterative tracking in architectural education.

3.3 Conceptual System Design and Discussion

Based on the problem analysis and theoretical insight, two conceptual frameworks were designed to address distinct yet interrelated pedagogical gaps:

3.3.1 Blockchain-Based Product Collection

This model conceptualise a decentralised submission and authorship validation system. Key features include:

- Chronological blockchain entry of each submission, from student identity initialisation to iterative assignments;
- Multi-use verification blocks, allowing multiple instructors or reviewers to validate a submission;
- Integration with a visual plagiarism detection engine, combining blockchain metadata with AI-based image matching

This system is envisioned as a complementary replacement for current LMS tools (e.g., Google Classroom), enabling holistic design evolution, feedback loops, and integrity checks across studio courses.

3.3.2 Blockchain-Connected BIM

This model proposes a direct integration of BIM platforms (e.g., Revit, ArchiCAD) with a private blockchain ledger that:

- Logs design commands and version histories as immutable blocks;

- Captures the workflow and progression of each student's design process;
- Enables replayable session audits for instructors to trace the student's modelling logic and changes over time

This approach transforms the role of educators into verifiers of creative logic and process authenticity, providing stronger protection against model reuse or manipulation. It is particularly suited for group projects and large-scale assessments, where manual supervision is limited.

These frameworks were intentionally designed to support transparency, authorship validation, and collaborative supervision.

3.4 Educational Relevance and Future Phases

The DBR approach ensures that these frameworks are pedagogically and contextually appropriate. They are not intended as final tools, but as proof-of-concept designs that will be developed into working systems via cross-disciplinary collaboration, undergo pilot testing in design studios, and be refined through student and lecturer feedback in iterative cycles. The frameworks also contribute theoretically by applying blockchain to design ethics, studio pedagogy, and academic integrity.

4.0 Conceptual Frameworks Design and Discussion

The study presents two conceptual frameworks developed using the Design-Based Research (DBR) approach: 1) the Blockchain-Based Product Collection Framework, and 2) the Blockchain-Connected BIM Framework. Both are designed to enhance authorship verification, prevent visual plagiarism, and improve supervision in architectural design education. These results respond directly to identified pedagogical issues in studio education, where digital duplication, fragmented supervision, and lack of traceability have compromised academic integrity.

4.1 Blockchain-Based Product Collection Framework

Figure 1 illustrates a decentralised, blockchain-based submission system structured to validate the originality and traceability of student work across multiple studio assignments and teaching teams. Each block in the chain represents a key event in the student's academic trajectory:

- Block 1 - initiates the student's participation and links their digital identity to the system

- Blocks 2 and 4 - represent student-generated products (manual sketches, renderings, or digital models);

- Blocks 3 and 5 are verification layers, where educators or studio coordinators review, assess, and timestamp their feedback or approval;

- The final block (Block n) contains a summary validation by program administrators or heads of studio, ensuring academic credibility for graduation or portfolio review.

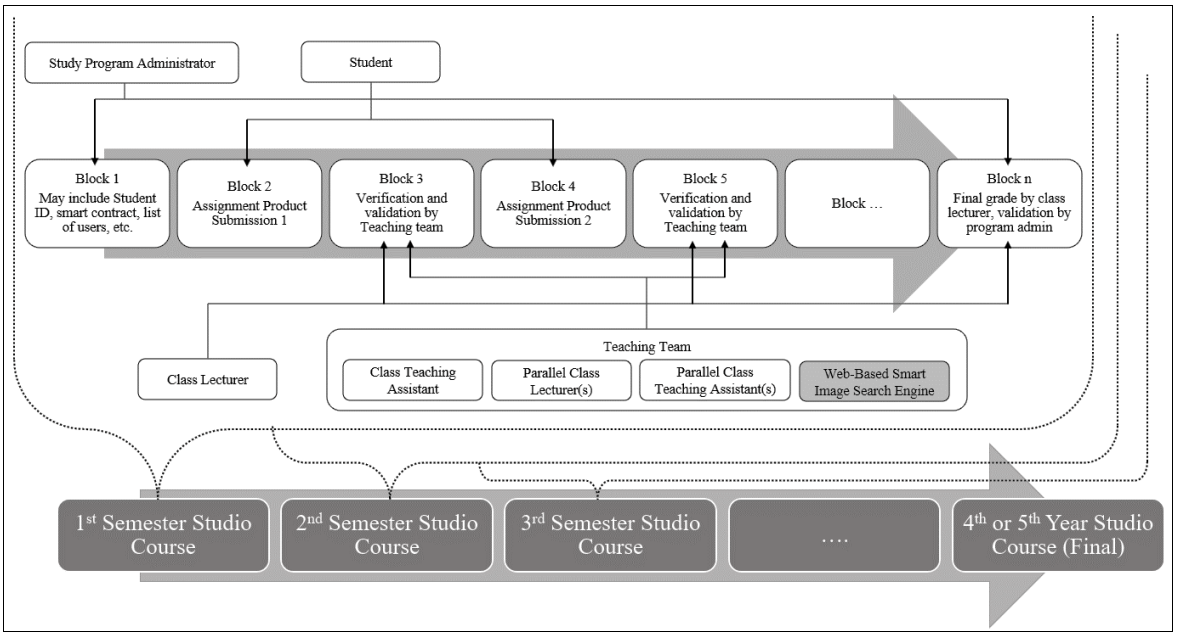

Figure 1: Blockchain-based product collection framework
(Source: Authors, 2025)

This framework enables transparent, multi-instructor supervision, particularly in parallel or team-taught studios. It also supports both manual and digital workflows, allowing students to scan hand-drawn content or submit files directly. More importantly, by storing work in an immutable blockchain ledger, the system prevents retroactive manipulation or duplication of submissions.

Additionally, the model incorporates the possibility of a smart image search engine, designed to compare visual submissions across the network using AI-powered pattern recognition (similar to Prihatno et al.(2023)). This allows visual plagiarism detection to occur in tandem with blockchain-based authorship verification. Moreover, this system shifts design assessment from static submissions towards a dynamic, time-stamped authorship ledger, reinforcing originality and accountability as part of the design process itself.

4.2 Blockchain-Connected BIM Framework

Figure 2 presents an advanced integration of blockchain within the BIM environment, capturing not just design files, but the creative workflow behind them. The figure outlines how each action taken within the BIM platform, such as adding components, modifiying geometry, or collaborating with peers, is recorded as a blockchain entry.

- Block 1 – initialises the file and project parameters;
- Blocks 2 and 4 – represent saved BIM sessions or working commands exported from the design software;
- Blocks 3 and 5 – involve educator or supervisor validation, confirming the originality and continuity of the student's design intent;
- The final block encodes the finished BIM file, linked with metadata and ownership information that could later be tokenised as an NFT.

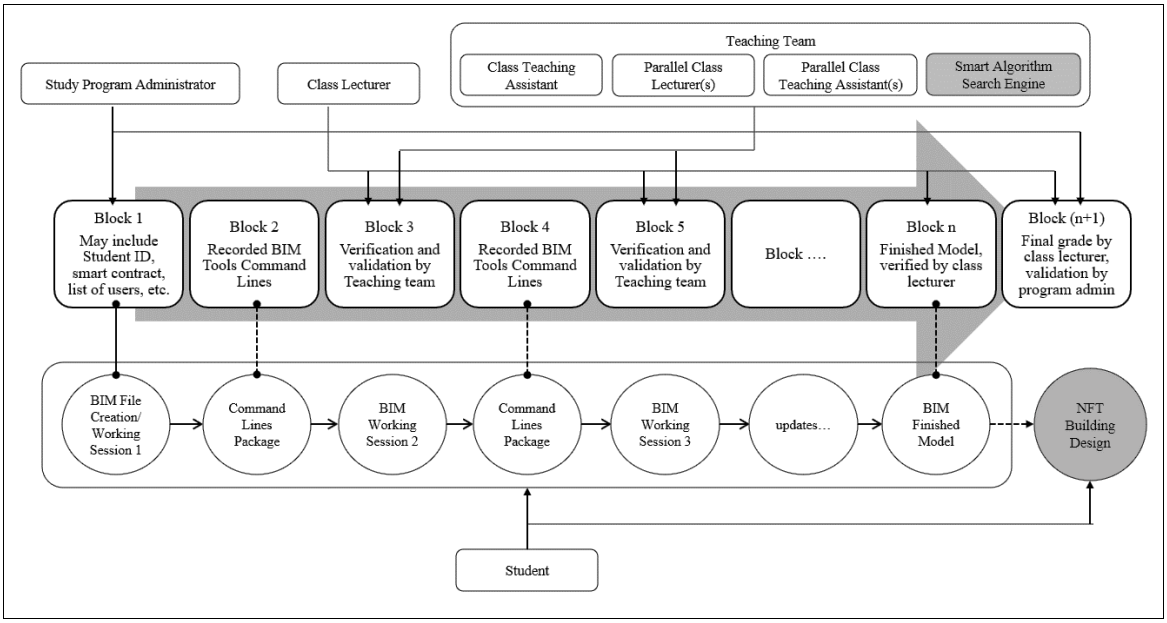

Figure 2: Blockchain-connected BIM framework
(Source: Authors, 2025)

This framework enables a replayable audit trail, offering educators the ability to review design evolution over time, akin to a version control system. Such functionality is

particularly critical in resolving authorship disputes or grading collaborative work, where distinguishing individual contributions can be challenging.

The integration of blockchain into the BIM environment echoes ideas proposed by Lu & Wu (2024), who advocate blockchain-enabled design IP protection. However, this framework localises that functionality within the studio setting, tailored for education rather than commercial practice. Furthermore, it aligns with the pedagogical emphasis on process reflection in architecture education, as promoted by Piątkowska (2020). This model transitions the BIM tool from static modelling interfaces into a pedagogical engine that documents intellectual labor, supports ethics, and validates authorship in real time.

4.3 Comparative Value and Pedagogical Implications

Together, both frameworks show how blockchain, NFTs, and teaching workflows can be unified to enhance academic integrity, creativity, and supervision in architecture design studios. The models provide multi-semester traceability, cross-studio comparability, and detailed authorship validation, capabilities long needed in design disciplines but absent from mainstream LMS platforms like Google Classroom.

These systems echo findings from Pfeiffer et al. (2022), who demonstrated how micro-credentials and partial assessments could be tokenized for educational verification. Similarly, Elmessiry et al. (2021) showed that gamified blockchain models, such as NFT awards, incentivise students while providing authentication. The current framewoks expand upon these insights by embedding verification not only into outcomes but into the full design process and pedagogical workflow.

Moreover, the incorporation of blockchain into architectural design education addresses the legal and ethical challenges discussed by Wojtkun (2022) and Greenstreet (2019), offering a scalable and secure way to protect intellectual property in design learning contexts. By ensuring that every revision, submission, and review is traceable, these models aim to reduce ambiguity around authorship, enhance fairness in grading, and promote accountability among both students and faculty.

4.3.1 Comparative Table: Traditional vs Blockchain-Enabled Studio Workflows

Table 1. Comparison of Traditional and Blockchain-Enabled Studio Workflows

Aspect	Traditional Studio Workflow	Blockchain-Enabled Framework
Submission Method	Manual or LMS-based uploads; no traceable submission chain	Immutable blockchain log with chronological, student-specific

		submission blocks
Authorship Validation	Instructor trust, no proof of originality	Timestamping ownership with student ID linked to each submission and design process
Supervision Model	Typical single reviewer, siloed feedback	Multi-instructor validation blocks enabling shared and parallel supervision
Assessment Focus	Product-centric grading (final output)	Process-inclusive assessment; reviews design iterations and modelling history
Plagiarism Detection	Text-based software (e.g., Tunitin); ineffective for visual work	Visual similarity search engine integrated with blockchain for 2D/3D design verification
Feedback Archiving	Informal, often lost across semesters	Instructor feedback stored on-chain as validation blocks, accessible across semesters
Collaborative Projects	Difficult to track contributions	Each user action or upload logged with metadata in group blockchain ledger
Portfolio Compilation	Student-curated, manually assembled	Blockchain ledger serves as live, validated portfolio updated throughout academic journey
Data Integrity & Security	Vulnurable to file loss, alteration, or misattribution	Cryptographically secured; blocks are tamper-proof and audit-ready
Scalability Across Courses	Hard to supervise at scale, especially with large cohort	Interoperable across courses, studios, and even institutions with permissioned blockchain layers

To further highlight the pedagogical innovation introduced by the proposed framework, Table 1 provides a comparison between conventional architectural studio workflow and blockchain-integrated systems. Traditional design studios often rely on decentralised communication, non-traceable submission methods, and subjective evaluation processes that leave room for inconsistency and undetected plagiarism. In contrast, the blockchain-enable models presented in this study promote transparency, secure authorship, and process-based assessment, fundamentally reshaping how educators manage and validate studenst works. These innovations directly respond to the need for integrity, supervision, and scalability in contemporary design education.

4.4 Limitations and Future Implementation Considerations

While conceptually strong, the framework is not without limitations. First, the conceptual nature of this study means that he frameworks have not yet been implemented or empirically tested in a live academic environment. Their effectiveness, scalability, and usability remain to be validated through prototype development and classroom trials. Technical integration poses another challenge; embedding blockchain systems within existing BIM platforms and institutional Learning Management Systems (LMS) will require considerable collaboration with software developers and IT infrastructure teams. This includes building user-friendly interfaces, ensuring compatibility with various file formats, and maintaining system stability during studio submission and feedback cycles.

Furthermore, successful implementation depends heavily on the digital literacy and readiness of both students and educators. Faculty members must be adequately trained not only to use the blockchain systems but also to interpret the data for fair and meaningful assessment. Without proper onboarding and support, the risk of underutilisation or resistance may undermine the intended impact. In addition, the immutability of blockchain raises important ethical and legal questions about student data privacy, particularly under a global data protection framework such as the General Data Protection Regulation (GDPR). Institutions must establish clear protocols for consent, data management and an off-chain storage solution for sensitive information.

Looking ahead, future research should focus on developing functional prototypes, conducting pilot studies across varied studio contexts, and collecting empirical evidence on system effectiveness. Evaluating how these frameworks influence student motivation, creativity, academic integrity, and educator workload will be crucial. Equally important will be exploring cross-disciplinary applications, adapting the system for other design-based fields such as product design, fashion, or digital media. These steps will be essential in transforming the proposed frameworks from conceptual solutions into impactful tools that shape the future of studio education

5.0 Conclusion

This study has proposed two conceptual blockchain-based frameworks, Product Collection and Blockchain-Connected BIM, which are designed to enhance authorship verification, prevent plagiarism, and improve transparency in architectural design education. These frameworks address critical challenges in studio pedagogy, where the authenticity of design work is often difficult to verify due to the iterative, collaborative, and visual nature of architectural design outputs. The research applies a Design-Based Research (DBR) approach to respond to a real-world academic integrity issue through theoretically grounded, pedagogically relevant system design.

The Blockchain-Based Product Collection Framework offers a decentralised structure for managing and validating student submissions across multiple semesters and studio classes. It enables chronological authorship tracking, multi-teacher verification, and integration with smart image detection to identify visual plagiarism. In parallel, the Blockchain-Connected BIM Framework ensures that the digital design process, which is typically conducted in BIM platforms, is recorded, verifiable, and resistant to manipulation. By logging design commands as immutable blockchain entries, this system provides an auditable history of design evolution supporting more robust supervision and fairer assessment.

The significance of this study lies in its contribution to bridging the gap between educational theory, emerging digital technologies, and the specific needs of architectural education. Unlike conventional anti-plagiarism tools, which focus solely on end-products, these frameworks embed integrity into the learning process itself. The repositioning of the roles of lecturers and teaching assistants as validators of the student's creative journey, rather than mere evaluators of final outcomes. This approach promotes accountability, deters unethical practices, and cultivates a culture of authorship and originality.

Despite its promise, this research is limited to a conceptual stage. Therefore, several avenues for future research are recommended. First, the development of a working prototype is essential to test the technical feasibility and user experience of the proposed systems. Pilot implementations in academic institutions could offer empirical insights into effectiveness, adaptability, and scalability. Second, integration with existing Learning Management System (LMS) and BIM Software platforms needs exploration to ensure interoperability and real-time feedback. Third, further studies should address data governance, ethical concerns, and regulatory compliance, particularly in the context of student data protection and institutional policy alignment.

Finally, interdisciplinary collaboration is vital, bringing together architectural educators, software developers, blockchain engineers, and legal scholars to co-develop sustainable, privacy-compliant, and pedagogically effective tools. If implemented effectively, these frameworks have the potential to redefine how design education handles creativity, supervision, and authorship in the digital age, building future studios that are not only innovative but also ethically robust and academically credible.

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