Comparative Effectiveness of Teaching Modalities in Architecture and Construction Management Education

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Abstract

The evolution of teaching modalities in higher education has created a pressing need to assess their effectiveness, particularly in disciplines such as Architecture and Construction Management (ACM), which depend heavily on studio-based, project-oriented, and collaborative learning. Despite the growing adoption of online and hybrid formats, their comparative impact on student success remains underexplored. This study evaluates and compares the effectiveness of online and face-to-face teaching modalities in Architecture and Construction Management (ACM) education using a comparative quantitative research design. The analysis draws on institutional academic performance data from a single university, with DFWI (Grade D, Fail, Withdrawal, Incomplete) rates serving as the primary indicator of student success across multiple semesters. Courses were selected based on their availability in at least two modalities and categorized into studios, seminars, and lectures, ensuring representation across freshman to upper-level offerings. Data analysis includes descriptive statistics to identify performance differences by modality.

While hybrid course sections are included where available, their limited representation constrains broader conclusions regarding hybrid delivery. Findings indicate that fully online instruction is associated with consistently higher DFWI rates in most technical, quantitative, and studio-based courses, while select lecture-based and theory-oriented courses perform comparably across modalities. This research contributes to the broader discourse on digital transformation in higher education, supports strategic curriculum planning, and enhances teaching and learning quality in ACM programs. By providing actionable insights, the study aims to improve curriculum design, strengthen student learning outcomes, and inform institutional decisions on effective teaching strategies in the evolving educational landscape.

Keywords: Teaching Modalities, Architecture, Construction Management, Online Learning, Hybrid Learning, Blended Learning, Course Performance Analysis, Higher Educational Technology

Introduction

The widespread adoption of multiple course modalities introduced during the pandemic, including face-to-face, traditional online, hybrid, and flexible delivery models, has reshaped expectations for teaching and learning in higher education. Although many theoretical subjects translate relatively seamlessly into the online space, practice-related subjects like Architecture and Construction Management present different sets of challenges in terms of their heavy emphasis on studio-based teaching, exercises, and group projects [3], [1]. Architecture requires hands-on activities, modeling, and group interaction, while Construction Management relies on

estimating labs, simulation, scheduling exercises, and site visits, which are traditionally facilitated through direct physical interaction [7], [14].

The sudden transition to online education during the pandemic highlighted issues with engagement, design cycles, and hands-on learning in solely online delivery. A body of literature from STEM and design-based courses indicates that while online education offers flexibility, it falls short in sociability and skills training when compared with in-class instruction [4], [5]. At the same time, advancements in technology, such as BIM software, virtual design studios, and virtual site visits, provide innovative means of delivering hands-on content remotely [18].

A hybridized form of learning, also known as “blended learning” or "mixed modality," proves to be a potent alternative that balances flexible schedules with hands-on experience. Findings show that "environments that combine different delivery methods, when done thoughtfully, support better learning outcomes than purely online, purely in-class, or other approaches that are exclusively dependent on technology" [15], [9], [13]. However, despite their widespread popularity, there remains a scarcity of comparative data on the use of these modalities in teaching Architecture and Construction Management courses.

This research contributes a preliminary step toward addressing this gap by examining performance data across online, hybrid, and traditional course delivery in architecture and construction management programs, offering an initial evidence-based perspective on emerging educational modalities.

Background and Literature Review

Globally, universities shifted to a broad range of teaching modes to ensure continuity of learning during the COVID-19 pandemic, and, as a result, accelerated the move towards online and hybrid education delivery models. Meanwhile, Architecture and Construction Management are among the programs most adversely affected by this transition since their teaching methodologies are greatly reliant on experiential learning. Architectural courses involve structured critiques, analysis, and peer-based experiential understanding, while Construction Management courses involve practical application of problem-solving techniques in estimating, scheduling, site analysis, and project simulation exercises [7], [12].

Although studies of online education for these disciplines present many challenges, studies also exist that provide insights into the potential benefits of online education that were revealed during the pandemic circumstances. These studies found that it was easy to access and continue education through online channels; however, students missed opportunities for interaction, participation, and hands-on experience, particularly in areas of construction-related courses [1], [3]. Studies on architecture education [13], [17], [8] reflect that theory courses responded adequately to online learning, yet design studio learning suffered due to the deprivation of spatial interactions, critiques, peer learning, etc. Further studies showed that work submission and

communication were easy through online channels; however, students missed design criticism, studio, and instant collaboration [10]. These studies agreed with other literature in higher education that suggested online channels were successful for covering knowledge but were not effective for teamwork, creativity, and practical activities [4], [5].

Benefits of blended, or hybrid, learning also exist for architecture studio environments. Studies identify that hybrid studios that mix digital modeling techniques with in-person review sessions foster participation, imagination, and reflection better than completely online studios [6], [18]. Research has shown that hybrid studios help preserve key studio-based learning values while also offering flexibility through asynchronous online tasks [8], [21].

Over various subjects, comparative modality studies reveal a consistent trend. Fully online delivery offers flexibility but suffers from relatively low engagement and performance in practical tasks [2], [20]. Face-to-face delivery remains superior for practical, collaborative, and spatial tasks that are fundamental to Architecture and Construction Management subjects [16], [19]. Online and face-to-face delivery combines, in a balanced manner, performance, satisfaction, and engagement in those subjects when designed in a way that combines both synchronous and asynchronous components effectively [15], [9].

However, despite all these developments, some research gaps exist. A good portion of available literature involves using student perceptions as opposed to backend performance data. There are limited studies that focus on analysis of DFWI rates, grades, and multi-semester data for Architecture and Construction Management courses. There are also limited mixed method designs that aim to synthesize internal data with perceptions of students and faculty members in determining modality efficiency [11]. As a start, this study offers a data-driven, discipline-specific comparative analysis of face-to-face, online, and hybrid learning for Architecture and Construction Management courses, providing evidence-based recommendations for a post-COVID curriculum.

Methodology

This study uses a comparative, quantitative approach to examine how different instructional delivery modes (i.e., online, face-to-face, and hybrid) relate to student performance in Architecture and Construction Management (ACM) courses. The study draws on institutional academic performance data collected across multiple semesters. Given the applied, studio-intensive, and technically demanding nature of ACM curricula, analyzing objective performance outcomes offers a practical and appropriate way to assess how well different instructional modalities support student success.

The research is conducted within Kennesaw State University and focuses exclusively on undergraduate ACM courses. Focusing on one institutional context helps address consistency in curriculum structure, grading practices, and academic expectations across courses and semesters.

Courses were selected using purposive sampling. To be included, a course had to be offered in online, face-to-face, or hybrid teaching modalities during the study period, enroll enough students to produce meaningful performance data, and represent a core component of the ACM curriculum. The selected courses span studio-based design courses, lecture-based theoretical courses, and technically oriented or laboratory-supported courses. This approach allows comparisons across similar instructional contexts while also capturing the diversity of course types students encounter throughout the curriculum. In total, ten Construction Management courses and ten Architecture courses were analyzed, covering academic terms. The course section serves as the primary unit of analysis. Each section is categorized by instructional modality, course type, academic term, and program. Student-level data were aggregated at the section level to protect anonymity and comply with institutional data governance policies. No personal identifiable information was accessed. All data were anonymized prior to analysis, and institutional approval was obtained before data extraction.

Student performance was measured using two quantitative indicators: final course grades and DFWI rates. DFWI, intended as the proportion of students earning a D or F, withdrawing, or receiving an incomplete grade, is a standard institutional metric used to assess academic risk and student persistence. This measure is particularly useful for comparing performance across courses and modalities because it captures both academic failure and non-completion, outcomes that may not be fully reflected in average grades alone. Final grades were used descriptively to provide additional context and to support interpretation of DFWI patterns across modalities and course types.

The analysis relies primarily on descriptive statistical methods. Mean DFWI rates were calculated for each course across instructional modalities and academic terms, allowing performance patterns to be examined over time. Cross-tabulations were used to explore how modality interacts with course type, with particular attention to differences among studio-based, technical, and lecture-based courses. Comparative charts were employed to visualize trends and patterns rather than to test formal hypotheses. This descriptive emphasis reflects the exploratory nature of the study, as well as practical constraints such as the uneven availability of hybrid course offerings, which limits the appropriateness of inferential statistical testing. Hybrid courses were included when available; however, their limited and uneven representation across programs. As a result, hybrid delivery outcomes are interpreted descriptively and contextually rather than as a basis for generalized conclusions regarding their effectiveness. Rather than treating hybrid delivery as directly comparable to fully online or face-to-face formats, hybrid outcomes were examined in context, with attention to course design and instructional structure. This approach allows hybrid results to inform broader discussions of modality integration without overstating their generalizability.

Several limitations should be noted. Specifically, (a) because the study relies on archival performance data, it cannot directly capture student engagement, instructional quality, or pedagogical differences within modalities; (b) instructor effects were also not fully controlled, as faculty assignments varied across semesters and delivery formats; (c) the study does not attempt to make causal claims or employ inferential modeling, instead it offers a descriptive comparison intended to inform curriculum planning and instructional decision-making. These limitations are

partially mitigated by the multi-semester scope of the data and by the consistency of observed patterns across programs and course types.

Data Analysis and Results

The study focused exclusively on programs within Kennesaw State University, specifically the Construction Management (CM) and Architecture programs. The study examined academic performance metrics (DFWI rates) for 10 courses from each program and reviewed 8 relevant pieces of literature for both CM and Architecture. DFWI stands for D, F, Withdrawal, and Incomplete grades and is widely used in academic assessment and institutional reporting. This combined approach provided insights into modality effectiveness across theory, technical, and studio-based courses within the two programs.

Table 1 summarizes the sampling frame for Construction Management (CM) by course, showing how many sections exist in each delivery modality. It directly supports course selection, representativeness checks, and later comparative analysis across modalities.

Table 1: Construction Management Courses: Total Sections* by Modality (Analysis)

Course	Online (Total)	Face-to-Face (Total)	Hybrid (Total)
Computer Applications in Construction	10	16	1
Mechanical & Electrical Building Systems	9	10	0
Risk & Quality Management	9	4	1
Construction Scheduling	9	11	0
Construction Project Management	10	10	0
Construction & Property Law	9	8	0
Construction Graphics	8	22	0
Introduction to Structures	4	13	0
Estimating I: Construction Quantities & Surveys	8	15	0
Construction Finance	6	11	0

*Construction Management course sections were offered from Fall 2022 through Spring 2025.

The Construction Management program offered a diverse set of courses across multiple semesters. In this analysis, Construction Management course sections offered from Fall 2022 through Spring 2025 were selected across three modalities: face-to-face, online, and, in some cases, hybrid. Core courses such as Construction Graphics (CM 2000) and Computer Applications (CM 3000) were consistently available in face-to-face format each term, with online sections offered intermittently and hybrid sections appearing in select semesters. Technical courses like Estimating I (CM 3410) and Construction Finance (CM 3800) showed strong representation in both face-to-face and online modalities, often with multiple sections per term, while hybrid offerings were limited. Courses such as Risk & Quality Management (CM 3400) and Mechanical & Electrical Systems (CM 3180) were primarily face-to-face with occasional online sections. Overall, the table demonstrates that while face-to-face delivery dominated across all semesters, online offerings were substantial for most courses, enabling comparative analysis of modality effectiveness. Hybrid sections were rare and concentrated in a few courses, indicating limited feasibility for three-way comparisons.

Table 2 provides the same modality distribution for Architecture, enabling parallel sampling and comparison from Fall 22 to Spring 25. The Architecture program primarily relied on face-to-face delivery for all its core courses. Design Communication courses were the most frequently offered, with Design Communication I scheduled in high volume (10–14 sections per term) and Design Communication II also widely available (5–8 sections per term). History & Theory courses such as Architecture Culture I and Architecture Culture III appeared less frequently, typically one to three sections per term. All studio courses selected Studio I, Studio II, Studio V, and Studio VI, were consistently offered in face-to-face format across multiple semesters, forming the backbone of the program's hands-on learning approach. As the table indicates, online and hybrid modalities were rare for these studios, limiting opportunities for modality-based comparisons within Architecture and reinforcing the dominance of in-person instruction for design-intensive coursework.

Table 2: Architecture Courses: Total Sections* by Modality (Analysis)

Course	Face-to-Face	Online	Hybrid
Design Communication I	51	4	0
Design Communication II	33	7	0
Architecture Culture I	15	1	0
Architecture Culture III	13	1	0
Studio I	69	4	0
Studio II	57	2	0
Studio V	26	0	1
Studio VI	31	1	0

* Design Communication I and Design Communication II were offered from Fall 2021 through Spring 2025. Architecture Culture I and Architecture Culture III were offered from Spring 2022 through Spring 2025, whereas the studio courses were offered from Spring 2020 through Spring 2025.

The data collection process focused on gathering academic performance metrics for selected courses in Construction Management and Architecture programs across multiple semesters. Institutional records were used to extract grades and calculate DFWI rates (Grade D, Fail, Withdrawal, Incomplete), which serve as key indicators of student success and progression. The dataset spans several terms and includes courses offered in different modalities—face-to-face, online, and hybrid—allowing for comparative analysis of teaching formats. This comprehensive data set provides the foundation for evaluating modality effectiveness and identifying patterns in student performance.

Figure 1 summarizes DFWI (D, Fail, Withdrawal, Incomplete) rates for key Construction Management courses across modalities, which is essential for comparative analysis. The analysis of DFWI rates for Construction Management courses reveals clear differences across teaching modalities shown in Figure 1. Online sections consistently show higher DFWI rates compared to face-to-face delivery, particularly in technical and quantitative courses. For example, Construction Finance (CM 3800) recorded the highest online DFWI rate at 28.67%, while face-to-face sections were much lower at 10.89%. Similarly, Estimating I (CM 3410) had elevated rates in both modalities, with 23.45% online and 18.57% face-to-face, indicating this course is challenging regardless of format. Courses such as Computer Applications (CM 3000) and Mechanical & Electrical Systems (CM 3180) also exhibited higher DFWI rates online compared to in-person delivery. In contrast, courses like Construction & Property Law (CM 4760) and Project Management (CM 4560) maintained relatively low DFWI rates across all modalities, suggesting these subjects are less sensitive to delivery format. Hybrid offerings were rare and showed mixed results, with Risk & Quality Management (CM 3400) reporting a notably high DFWI rate of 22.20%.

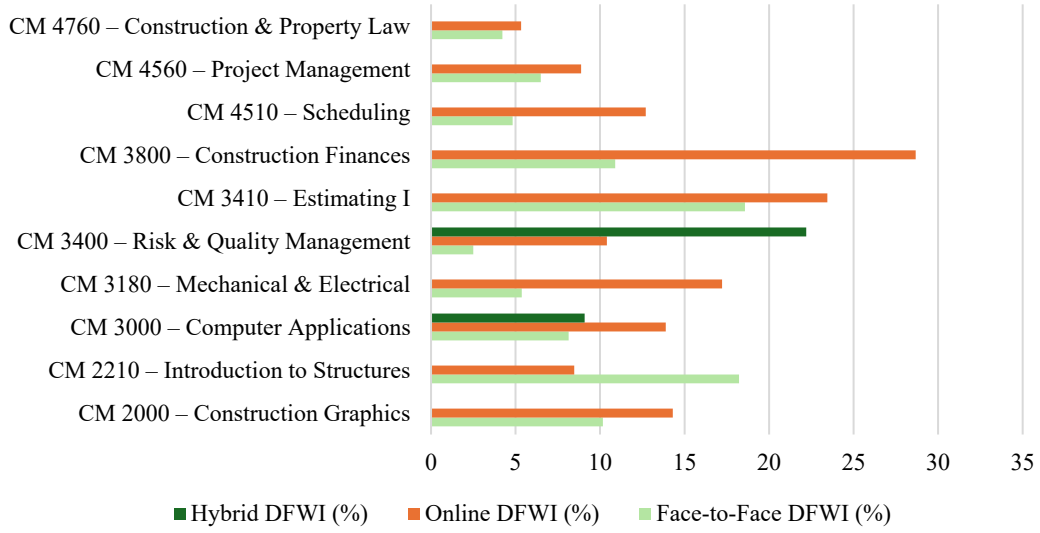

Figure 1. Construction Management Courses – DFWI Average Rates by Modality

Figure 2 provides similar data for Architecture courses, enabling cross-program comparison. Analysis shows significantly higher DFWI rates for online sections of technical and software intensive courses (Design Communication I and II) and for online versions of foundational studio courses compared to face-to-face delivery. Design Communication I recorded the highest online DFWI rate at 46.05%, while face-to-face sections were lower at 25.80%. Similarly, Design Communication II had an online DFWI rate of 21.04% versus 10.06% in face-to-face sections. Foundational studio courses, which form the core of architecture education, also exhibited elevated online DFWI rates, with Studio I and Studio II reaching 37.50% and 33.33% online, compared to 27.73% and 13.35% in face-to-face. Advanced studios such as Studio V and Studio VI maintained very low DFWI rates across all modalities, with hybrid delivery appearing only in Studio V (5.56%). History & Theory courses showed mixed results, with Architecture Culture III having a high face-to-face DFWI rate at 24.11% and a much lower online DFWI rate (5.88%). Overall, the table highlights that online delivery poses significant challenges for design communication and early studio courses, while advanced studios and theory-based courses perform better across modalities.

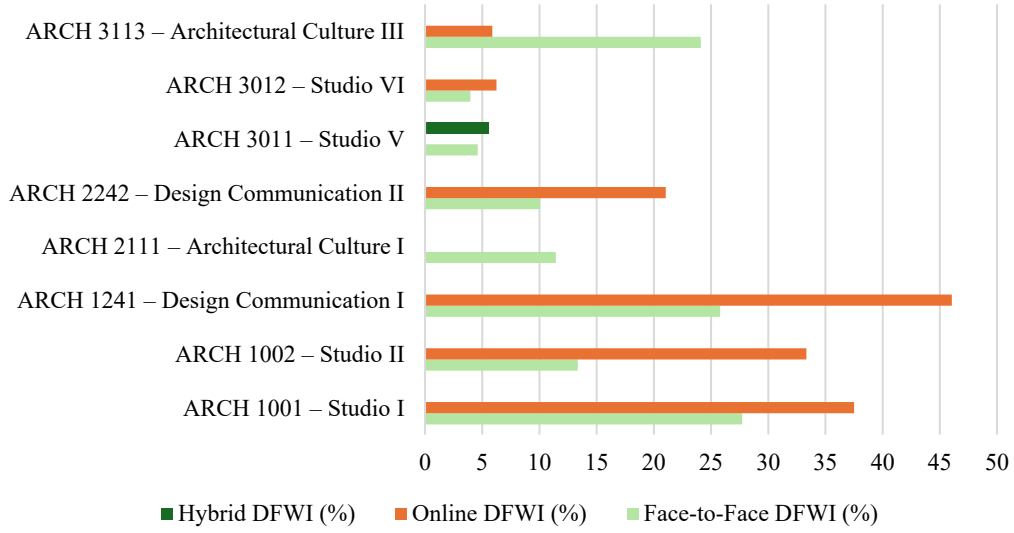

Figure 2. Architecture Courses – DFWI Average Rates by Modality

Grade Analysis

Construction Management Grade Analysis by Teaching Modality

In most of the Construction Management courses, online sections reported the highest rate of DFWI. This was particularly true for courses that involved technical subjects, quantification, and software. To this end, in CM 3800 – Construction Finance, the highest rate of online DFWI reached 40%, while in CM 3410 – Estimating I, showed over 35% DFWI in various semesters. Additionally, CM 3000 – Computer Applications, also shows high rates of DFWI grades, including 30.77% in Summer 2023.

The face-to-face sections all showed a consistent rate of lower DFWI, with some semesters staying below 10% for the most part. Some of the classes that performed well in a face-to-face setting were CM 4510 (Scheduling), CM 4760 (Construction Law), and CM 3400 (Risk & Quality Management). There was a noticeable exception in CM 2210 (Introduction to Structures), as there was a huge spike of 53.3% in Spring 2024 for a face-to-face class.

While hybrid delivery was restricted in this data set, it appears that there is some variation in the results. The hybrid portion of CM 3400 showed a 22.2% DFWI rate, which is high for a successful course delivery. On the other hand, CM 3000's hybrid course showed a significantly lower rate of 9.09% for DFWI grades.

Architecture Grade Analysis by Teaching Modality

Among the architecture courses studied, technical, software intensive courses and foundational studios showed high to extremely high DFWI rates. In ARCH 1241, Design Communication I,

online DFWI initial rates were 73.3%, but this improved over time to 22.2% as of Spring 2025. Another course, ARCH 2242, Design Communication II, showed a comparable trend of higher DFWI in online courses than in face-to-face courses.

Lecture-based courses showed a stronger performance in terms of their results. The ARCH 2111 course (Architecture Culture I) kept a remarkably low DFWI rate at 3.13%. The ARCH 3113 course (Architecture Culture III) showed that while face-to-face classes kept a rate of 22-26% for DFWI grades, the online class kept a notably low DFWI rate of 5.88%, indicating that theoretical lectures courses transitioned well online.

Across both programs, the institutional performance data revealed a consistent pattern of higher DFWI rates in online courses. Technical CM courses, as well as software-intensive and foundational design ARCH courses, were among the most affected. In contrast, face-to-face instruction consistently demonstrated the strongest performance outcomes, with the lowest DFWI rates observed in this modality for both CM and ARCH courses. Results of hybrid instruction were mixed but encouraging. Some courses, such as CM 3000, performed better in hybrid delivery than in online delivery. Other courses, such as CM 3400, were negatively impacted.

Discussions

Classroom, face-to-face instruction remains the most effective modality for ACM courses, particularly those that are application-oriented, quantitative, or design-based. By contrast, online learning presents the greatest challenges, as reflected in its consistently higher DFWI rates across both programs. Taken together, these findings indicate that modality meaningfully influences student performance and that online course design must intentionally address instructional needs specific to technical and foundational courses.

The findings of this study provide empirical support for long-standing assumptions within Architecture and Construction Management education regarding the relationship between instructional modality and student performance. In general, across both programs, face-to-face delivery consistently exhibited lower DFWI rates, particularly in courses that are technical, software-intensive, quantitative, or in foundational studio-based courses that benefit from informal peer exchange and immediate critique. These outcomes seem to reinforce the central role of in-person instruction in disciplines that depend on iterative feedback, spatial reasoning, collaborative problem-solving, and hands-on engagement. While online learning environments offer flexibility and expanded access, the performance data suggests that these advantages do not necessarily offset the pedagogical demands inherent to applied ACM coursework and case-by-case decision making is required.

The elevated DFWI rates observed in online sections of Construction Management courses such as estimating, finance, computer applications, and building systems indicate that students may

experience greater difficulty mastering technically complex material without sustained, real-time instructional support. In addition, similar patterns emerge in Architecture, where foundational design communication courses and early studios show substantially higher DFWI rates in online formats. These courses introduce students to disciplinary conventions, representational techniques, and design processes that are typically reinforced through studio culture, informal peer exchange, and immediate critique. The absence or reduction of these elements in fully online environments appears to disproportionately affect student persistence and success at early stages of the curriculum. At the same time, the results demonstrate that modality effects are not uniform across course types. Lecture-based and theory-oriented Architecture courses, particularly history and theory offerings, performed comparatively well in online formats and, in some cases, exhibited lower DFWI rates than their face-to-face counterparts. These results suggest that courses emphasizing theoretical, fact-based, or content-driven learning outcomes may be well suited for online delivery when instructional design supports structured content engagement and assessment. This distinction is critical when interpreting generalized claims about modality effectiveness and reinforces the importance of aligning delivery format with course content rather than assuming uniform effects across all ACM coursework.

Although hybrid sections were included in the dataset, their small number and inconsistent adoption across courses limit the credibility of broader conclusions regarding hybrid effectiveness. In some cases, hybrid formats yielded lower DFWI rates than fully online delivery, suggesting that partial in-person engagement can mitigate some of the challenges associated with remote learning. In other cases, hybrid sections exhibited elevated DFWI rates, indicating that hybrid delivery alone does not guarantee improved performance. These findings underscore that hybrid instruction is not inherently effective; rather, its success depends on how in-person and online components are integrated to support course-specific learning objectives, particularly in technical and applied contexts.

Differences across course levels further complicate the relationship between modality and performance. The authors notice that advanced Architecture studios exhibited consistently low DFWI rates regardless of delivery format, while early studios showed heightened sensitivity to online instruction. This pattern could suggest that student preparedness, disciplinary acclimation, and self-regulation may moderate modality effects. In general, upper-level students, having developed stronger design competencies and learning strategies, may be better positioned to navigate alternative instructional formats, whereas early-stage students appear to benefit more from structured, immersive, face-to-face environments.

Overall, instructional modality seems to play a meaningful role in student performance within Architecture and Construction Management education, and its effects are mediated by course type, curricular position, and instructional design. Rather than framing modality as a binary choice, the results point toward the need for deliberate alignment between delivery format and pedagogical intent.

Summary and Conclusions

This study provides a data-driven examination of instructional modality effectiveness within a single institutional context, using DFWI rates as the primary performance indicator. By focusing on DFWI rates and course-level outcomes rather than student perceptions alone, the analysis offers a grounded assessment of how face-to-face, online, and hybrid delivery formats relate to student success in applied, studio-intensive disciplines.

The results indicate that face-to-face instruction remains the most reliable modality for supporting student performance in technical, quantitative, and studio-based courses across both programs. However, the findings also demonstrate that fully online delivery can be effective for certain theoretical and fact-based courses, where students showed comparable or lower DFWI rates than in face-to-face settings. These distinctions underscore that instructional modality should be selected based on course content and learning objectives rather than applied uniformly across programs.

Importantly, the findings are also consistent with previous studies and demonstrate that online instruction can be effective for theory-based and lecture-oriented courses, reinforcing the argument that modality decisions should be course-specific rather than program-wide. These outcomes support a strategic, evidence-informed approach to curriculum planning in which instructional formats are selected based on pedagogical fit, course objectives, and student developmental level.

Several limitations must be acknowledged. The study is confined to a single institutional context and relies on descriptive analysis of archival performance data, limiting the ability to account for instructor effects, variations in course design, or student engagement. Causal claims are therefore not advanced. Nonetheless, the consistency of observed patterns across multiple semesters, programs, and course types strengthens the relevance of the findings for institutional decision-making.

Future research should extend this work through mixed method designs that integrate qualitative insights from students and faculty, as well as through broader, multi-institutional analyses to enhance generalizability. In addition to identifying aspects of online and hybrid delivery that were less effective, further examination of instructional components that show the greatest promise, particularly within hybrid models for upper-level studios and theory-based courses, would offer valuable guidance for pedagogical refinement. Overall, this study affirms that modality matters in Architecture and Construction Management education, but that its effectiveness depends on thoughtful alignment with disciplinary practices and learning objectives. As institutions continue to refine post-pandemic instructional strategies, these findings offer empirical guidance for balancing flexibility with educational effectiveness.

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