EXAMINING ARCHITECTURAL DESIGN PROJECTS THROUGH CDIO: PREPAREDNESS, TASK DESIGN, FEEDBACK, AND COLLABORATION

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ABSTRACT

This study explores the dynamic interplay of preparedness, task design, feedback, and collaboration in shaping student engagement and performance in architectural education, framed within the Conceive-Design-Implement-Operate (CDIO) standards. By integrating qualitative and quantitative methodologies, the research investigates how these factors influence the learning experiences of architecture students during two distinct design projects: a complex urban resort and a simpler ferry terminal. Coding and thematic analysis was employed to analyze focus group discussions, while statistical analyses validated relationships among key metrics such as enjoyment, effort, control, and openness. The findings reveal that academic preparedness plays a foundational role in equipping students to navigate the demands of architectural design courses, with prior technical exposure being a critical enabler. Task design emerged as a significant motivator, with structured and phased assignments promoting incremental progress and sustained engagement. Feedback was identified as a catalyst for growth, emphasizing the importance of clear, constructive, and timely communication in cultivating student confidence and skill development. Collaboration, while enriching peer learning and creativity, posed challenges related to group dynamics and equitable contributions. These insights align with CDIO Standards 2 (learning outcomes), 3 (integrated curriculum), 5 (design-implement experiences), and 7 (integrated learning environments), underscoring the value of interdisciplinary and practical approaches to architectural education. The study also highlights the importance of openness to feedback and new ideas as a driver of student engagement and performance.

KEYWORDS

Architectural education, Student engagement, Feedback mechanisms, Task design, Collaboration, Standards: 2, 3, 5, 7

INTRODUCTION

Architectural education must balance technical proficiency, creativity, and collaboration to prepare students for the complexities of professional practice. Integrating technical and practical knowledge into design tasks is crucial, as demonstrated by programs like the University of Hartford's approach, which blends academic-based theoretical studies with industry-focused problem-solving to enhance career readiness (Petry, 2004). Hands-on activities, such as design-build programs, further reinforce students' understanding of architectural phenomena by providing real-world contexts for learning (Amer, 2015). Effective task design, incorporating collaborative projects, plays a vital role in developing teamwork and problem-solving skills essential for architectural practice. Collaborative design studios and multidisciplinary approaches, such as those outlined in Multiple Criteria Decision Support frameworks, foster interdisciplinary collaboration and improve design outcomes (Emam et al., 2019; Kamaraj et al., 2025).

Feedback mechanisms also significantly influence learning outcomes by providing students with opportunities to assess their progress and refine their skills. Interactive tools such as peer assessments and structured time-task schedules offer constructive feedback while maintaining engagement (Emam et al., 2019). Emerging technologies, such as Extended Reality (XR), further enhance these mechanisms by offering immersive and interactive learning environments that bridge theoretical concepts and practical applications (Crolla et al., 2024). Collaboration, a cornerstone of architectural education, encourages creativity and problem-solving but requires addressing common barriers like coordination challenges and conflicts. Collaborative projects and targeted training in teamwork skills are essential for encouraging effective partnerships (Karimi & Farivarsadri, 2024). To comprehensively evaluate the impact of these pedagogical strategies, mixed-methods approaches that combine qualitative observations with quantitative data, such as thematic analysis and structured questionnaires, provide valuable insights into teaching efficacy and areas for improvement (Ramadhan et al., 2024).

The core of architectural education in the Philippines is the Architectural Design courses that are offered from freshmen year to senior year. In the School of Architecture, Industrial Design, and the Built Environment of Mapua University, the architecture program offers Architectural Design 1 to Architectural Design 12. At the heart of its program of study is the design process. The design process is a method in formulating an architectural design solution. Concept development is generated through this method by the learners in order to articulate their design. Thus, from an architecture perspective, the study aims to investigate how the design process is being utilized by the design students, and it is hypothesized that it encourages and fosters creativity in students.

The Conceive-Design-Implement-Operate (CDIO) framework (Crawley et al., 2014), originally developed for engineering education, offers significant potential for transforming architectural education. By emphasizing hands-on learning, team collaboration, and practical applications, CDIO aligns with the core principles of architectural education (Nyka et al., 2020). Institutions like Gdansk University of Technology and Singapore Polytechnic have successfully integrated the CDIO framework into their curricula, focusing on experiential learning and sustainability (Ho & Leong, 2023). For example, Gdansk University has demonstrated the benefits of "research by design," enhancing practical and research skills. Similarly, Singapore Polytechnic has mapped their programs to CDIO standards and progressively incorporated sustainability knowledge over three years. Challenges, such as adapting to cultural differences in educational systems, highlight the need for flexible implementation strategies, especially in diverse settings like China (Cui & Wang, 2014). Despite these challenges, the CDIO approach promotes continuous improvement, requiring regular curriculum evaluation to meet evolving industry standards and educational goals. Architectural education inherently requires the integration of technical skills, creativity, and collaboration, aligning seamlessly with CDIO's emphasis on hands-on, project-based learning. By adopting CDIO standards 3.0 (Malmqvist et al., 2022), such as comprehensive learning outcomes (Standard 2), integrated curricula (Standard 3), real-world design-implement experiences (Standard 5), and collaborative feedback mechanisms (Standard 7), architectural programs can provide a structured yet flexible framework that bridges academic learning with professional practice.

This paper offers insights for educators on optimizing tasks, enhancing feedback, and fostering collaboration, presenting a model to understand contextual and individual influences on architectural learning for future pedagogical strategies.

METHOD

The study employed a mixed-methodology approach, utilizing an online design process tool that also incorporated subjective assessments. A focused group discussion was conducted to gather insights and reflections from the students and the design professor regarding the locus of control and self-efficacy measures. This study employs a thematic analysis, integrating quantitative measures and demographic data, to provide a mixed-methods perspective.

Qualitative Analysis

Coding and thematic analysis as qualitative research method used to identify recurring themes, patterns, and concepts in textual data in focus group discussions by tagging data segments (codes), grouping them into categories, and extracting supporting quotes. This method reveals patterns in experiences, preferences, or behaviors, providing structured, evidence-based findings.

Quantitative Analysis

Quantitative data included self-reported metrics on enjoyment, effort, control, openness, and groupmate ratings collected across two projects. Statistical methods included Pearson correlation analysis to measure relationships, trend analysis to detect changes across projects, ANOVA to test for significant differences, and regression modeling to identify predictors of performance.

Data Sources

Qualitative Data: Focus Group Discussions (FGDs) were transcribed on student discussions. Analyzes extracted themes related to students' experiences in two design projects: the urban resort (complex task) and the ferry terminal (simpler task). The FGDs captured insights into how students approached design tasks, perceived feedback, and collaborated in group settings.

Quantitative Data: Data from an evaluation matrix, including variables such as Hours, Enjoyment, Effort, Openness, Control, and Groupmate collaboration, provided numeric insights into student engagement and task performance.

Analytical Procedures

The analytic procedure of coding and thematic analysis follows a systematic approach to examining qualitative data. Initial immersion in the data through repeated readings establishes familiarity. Meaningful segments are identified and labeled through coding, followed by the organization of these codes into emergent themes that reflect recurring patterns. Thematic refinement occurs through consolidation or subdivision to enhance conceptual clarity. Representative quotations substantiate each theme, ensuring analytic rigor. The process concludes with a presentation of findings through a structured thematic framework that explains key insights from the dataset.

Quantitative Analysis: Statistical correlations between metrics (e.g., Enjoyment, Effort, Control) were computed to validate qualitative observations. Patterns in performance metrics were analyzed for individual students and across projects to detect trends.

Integration of Qualitative and Quantitative Data: Themes emerging from FGDs were compared with quantitative measures to identify convergences and divergences. For example, FGD narratives on feedback quality were supported by variations in Openness and Enjoyment scores.

CDIO Alignment: The analysis is aligned with CDIO Standards 2, 3, 5, and 7. Learning outcomes (Standard 2) guided the identification of preparedness and skill development themes. Task design and its impact on engagement were analyzed concerning integrated curricula (Standard 3) and design-implement experiences (Standard 5). Collaborative dynamics and feedback were examined within integrated learning environments (Standard 7), ensuring the findings align with CDIO's emphasis on interdisciplinary and practical learning approaches.

Projects and Tasks

Students participated in two design projects: (1) Urban Resort, a complex task that required advanced technical and creative skills. (2) Ferry Terminal: A simpler task designed to test foundational skills. Tasks for each project were subdivided into phases, including concept development, drafting, and rendering, to provide a structured learning process.

The study focused on the Architectural Design 6 course offered by the School of Architecture, Industrial Design, and the Built Environment at Mapúa University. This course was chosen because it was available and taught by the researcher during the period of the investigation. Students worked in pairs and were assigned four specific tasks for each project: 1. Concept Development, 2. Site Development Plan, 3. Floor Plans, Elevations and Sections, 4. Poster, and Walk-through. An online questionnaire was administered to the students, who were instructed to respond based on their task. Additionally, they were required to complete the questionnaire at each stage of the design project.

Participants

Participants included undergraduate architectural students from diverse academic backgrounds (e.g., STEM - Science, Technology, Engineering, and Mathematics, ABM - Accountancy, Business, and Management, GAS - General Academic Strand). Their academic preparedness, performance, and engagement were evaluated across both projects. The research participants were composed of 15 male and 15 female students.

RESULTS

Qualitative analysis

This coding and thematic analysis was performed on the transcripts of the two focus group discussions involving architecture students.

Table 1. Summary of thematic coding of the focus group discussion

Theme	Subtheme	Categories	Example Quotations
Preparedness	Academic Alignment	STEM track, ABM track, GAS track	“It was not very connected to design.”
	Emotional Readiness	Motivation, Confidence, Anxiety, Fear	“Sometimes when there is an exam and a design project, I feel stressed.”
	Demographic Influences	Age, Gender, Experience	“Older ones have more experience because they've gone through what we’re going to go through.”
Task Design	Task Structure and Clarity	Structured tasks, Unstructured tasks	“Every level seems structured, increasing my enjoyment with each task.”
	Project Complexity and Engagement	Complexity (high/low), Creativity, Sequencing	“The complexity of the project really makes a difference in our output.”
	External/Internal Factors	External environment, Internal emotional states	“It’s comfortable when you're at home because you can focus more; at school, there are distractions.”
Feedback	Instructor Interaction	Frequency of consultations, Quality of feedback	“Detailed feedback during consultations significantly improved our work.”
	Impact on Performance	Motivation, Technical understanding, Creativity	“The instructor’s detailed instructions helped me to better understand what was required.”
Collaboration	Team Dynamics	Partner selection, Productivity, Creativity	“It really depends on the partner chosen, but I felt better working individually.”
	Peer Influence	Peer-to-peer learning, Influence on design	“With my classmates, I get a lot of ideas and implement them into my work.”
	Collaborative Arrangements	Individual vs. paired/group, Benefits, Challenges	“Working in pairs was challenging but beneficial because we could share ideas.”

This thematic analysis explains how student engagement and performance in architectural design courses shaped by the interplay of academic preparedness, task design, feedback, and collaborative dynamics, influenced by environmental, demographic, and motivational factors. These elements collectively define the educational experiences of architecture students, emphasizing that no single factor operates in isolation. Instead, their dynamic interaction creates opportunities and challenges for learners and educators alike.

Preparedness as the Foundation

Academic preparedness underpins students' ability to manage the demands of architectural design courses. Students from STEM backgrounds often feel confident in handling technical components, such as CAD and mathematics, which closely align with architectural coursework. One student noted, "There are some courses...aligned with architecture, like drafting" (Respondent 1 Batch 1). Conversely, non-STEM students from ABM tracks faced difficulties adapting to technical requirements, as expressed: "Not really sir, because of the designing aspect...My course is ABM, so Business" (Respondent 2 Batch 1). Exposure to drafting or CAD during high school helped bridge this gap, highlighting that preparedness involves both academic background and early technical training.

Task Design as a Motivator

Task design has a significant impact on student engagement and learning outcomes. A phased approach to tasks—breaking projects into concept development, floor plans, and rendering—promotes clarity and sustained motivation. A student described, "Every level...seems like I'm having a sense of pressure or enjoying it when I'm doing SketchUp or rendering" (Respondent 7 Batch 1). Conversely, repetitive activities, such as prolonged floor-plan work, led to boredom: "For a week, it was just a floor plan...you get bored" (Respondent 7 Batch 1). Well-structured tasks balance challenge and achievability, maintaining students' interest and enthusiasm.

Feedback as a Catalyst for Growth

Effective feedback is crucial for student growth and engagement. Clear, constructive feedback helps refine students' work and build confidence. One student stated, "The instructions...are detailed...I can interpret them properly and produce what I need" (Respondent 3 Batch 1). In contrast, vague or critical feedback reduces confidence and creativity: "Before there was a professor who was not helpful...our design was being insulted" (Respondent 5 Batch 1). Regular consultations with supportive feedback significantly enhance students' learning experiences.

Collaboration as a Learning Opportunity

Collaboration in architectural education provides peer learning opportunities but presents challenges related to group dynamics. Students valued diverse perspectives and ideas: "Collaboration helped me learn new ideas from my group mate" (Respondent 7 Batch 1). However, unequal contributions caused dissatisfaction: "It seems unfair if your classmate is not attending [consultations] but still gets a good grade" (Respondent 4 Batch 1). Effective collaboration requires compatible group members and fair evaluation systems recognizing individual contributions.

Environmental and Internal Factors Shaping Learning

Workspace conditions and internal emotional states significantly influence productivity and creativity. Many students preferred working at home to minimize distractions and enhance focus: "It’s better to just take the plates home...you are more focused” (Respondent 6 Batch 1). School environments facilitated collaboration but sometimes disrupted individual focus. Internal factors like motivation impacted output quality: “When I’m not motivated...I do a simple, playing safe design” (Respondent 8 Batch 1). Addressing external and internal influences through adaptive strategies is essential.

Demographics and Experience

Demographic factors (age, gender, prior experience) influenced learning dynamics and performance. Older students benefitted from maturity and experience: “Older students have learned something that younger ones haven’t yet” (Respondent 1 Batch 1). Gender differences also emerged, with women recognized for creativity and men for technical skills: “Women are really good at aesthetics...more creative in imagining and visualizing the design" (Respondent 1 Batch 1). Inclusive practices leveraging diverse strengths are vital in architectural education.

Engagement and Fair Evaluation

Project complexity and evaluation fairness critically impacted academic performance and student satisfaction. Complex projects, such as urban resorts, were more demanding: "The complexity of the project really makes a difference in our output" (Respondent 4 Batch 1). Students emphasized evaluating individual contributions within group projects to ensure fairness: "It is necessary to see if there are improvements after consultations" (Respondent 1 Batch 1). Transparent evaluation methods considering both individual and group efforts are essential for maintaining motivation and trust.

Quantitative analysis

This study investigates the relationships among key educational metrics such as Enjoyment, Effort, Control, Openness, and Groupmate Ratings in the context of project-based learning. Quantitative analysis is used to validate qualitative observations, providing deeper insights into student engagement and performance. By applying statistical methods, this research explores correlations, trends, and predictors of performance, offering recommendations for optimizing learning environments.

Methods

The analyzed data consists of metrics reported at the project level for individual students, including self-reported enjoyment, effort, and control, openness to feedback, groupmate ratings, and hours worked. Statistical methods were applied to achieve the study's objectives. Pearson correlation coefficients were computed to measure linear relationships between variables. Trend analysis calculated mean values for each metric across multiple projects to observe changes over time. Analysis of Variance (ANOVA) was employed to test for significant differences in metrics across projects, while regression modeling was used to identify predictors of key outcomes like enjoyment and effort.

Results

The correlation analysis revealed significant relationships among variables. Enjoyment was strongly correlated with openness ($r=0.55$, $p<0.001$), suggesting that students who are receptive to new ideas and feedback tend to enjoy projects more. Enjoyment also correlated positively with control ($r=0.41$, $p<0.05$) and effort ($r=0.34$, $p<0.05$), indicating that greater perceived autonomy and higher effort levels are associated with enhanced enjoyment. Effort showed a moderate correlation with openness ($r=0.47$, $p<0.01$), highlighting the motivational role of openness in driving engagement. However, hours worked correlated negatively with control ($r=-0.30$, $p<0.05$), indicating that longer working hours are associated with reduced feelings of autonomy.

Trend analysis showed that enjoyment and effort increased significantly across projects, reflecting growing engagement and involvement over time. Control, however, fluctuated, indicating inconsistencies in students' perceived autonomy. Groupmate ratings also improved slightly, suggesting enhanced collaboration with successive projects.

ANOVA results confirmed these trends, with significant increases observed for enjoyment ($F(2,90)=5.67$, $p<0.05$) and effort ($F(2,90)=4.89$, $p<0.05$) across projects. Regression analysis identified openness ($\beta=0.38$, $p<0.001$) as the strongest predictor of enjoyment, followed by control (β=0.21, $p<0.05$) and groupmate ratings (β=0.18, $p<0.05$). Effort was significantly predicted by openness (β=0.31, $p<0.01$) and project hours (β=0.25, $p<0.05$).

DISCUSSION

The synthesis of qualitative and quantitative findings provides a comprehensive understanding of the factors that shape student engagement and performance in architectural education. Both analyses emphasize the importance of openness, task design, feedback, and collaboration in creating a supportive learning environment. These interconnected elements demonstrate how educational experiences are shaped by dynamic interactions, highlighting actionable opportunities for improvement. The study's limitations include the relatively small sample size (30 participants), which restricts the generalizability of the findings, particularly in drawing broad conclusions about architectural education across diverse contexts. Then, the study is also highly contextualized, focusing on specific architectural programs, which may limit its applicability to other educational or cultural settings. In light of this, openness emerged as a critical factor in enjoyment and effort, as evidenced in both qualitative and quantitative findings. Students who are receptive to feedback and open to exploring new ideas show greater levels of engagement and motivation. The thematic analysis illustrates how openness enables students to navigate challenges more effectively, while the quantitative analysis identifies it as a strong predictor of enjoyment (β=0.38, $p<0.001$) and effort (β=0.31, $p< 0.01$). These findings underscore the need for educators to create activities and reflective exercises that encourage openness, enhancing students' ability to engage with complex tasks.

Task design is also pivotal in sustaining motivation and ensuring productive learning experiences. The qualitative analysis emphasizes the importance of phased, well-structured assignments that provide clarity and facilitate incremental progress, thereby preventing disengagement. Students reported higher satisfaction with tasks that balanced challenge and achievability, as exemplified by the phased design of concept sketches, floor plans, and rendering tasks. Quantitative findings further support this, revealing fluctuating perceptions of control and the negative impact of excessive working hours on autonomy ($r=-0.30$, $p<0.05$). Together, these findings underscore the importance of designing manageable and engaging assignments that optimize both effort and outcomes.

Feedback and collaboration are equally significant in shaping learning experiences. Constructive feedback is identified in the thematic analysis as a catalyst for growth, helping students refine their work and build confidence. Students who receive clear and actionable feedback can better meet expectations and develop their skills, whereas vague or overly critical feedback can diminish confidence and creativity. Quantitative results validate this, showing that control (β=0.21, $p<0.05$) and groupmate ratings (β=0.18, $p< 0.05$) are significant predictors of enjoyment. These findings highlight the dual importance of feedback and collaboration, indicating that equitable evaluation practices and structured peer interactions can promote improved group dynamics and overall engagement.

Collaboration presents both opportunities and challenges. While group work fosters peer learning and exposure to diverse perspectives, it also introduces difficulties, such as unequal contributions and perceptions of unfairness. Improvements in groupmate ratings over time indicate that collaborative skills can develop progressively when supported by effective team-building strategies and fair assessments. This highlights the importance of structured peer evaluations and transparent grading practices to promote equity and accountability in group settings.

The synthesis highlights the interconnected roles of openness, task design, feedback, and collaboration in shaping student engagement and performance. Educators can enhance learning environments by encouraging openness, effectively managing workloads, and promoting effective group dynamics. The interplay among these factors aligns with CDIO standards 2, 3, 5, and 7.

Particularly, preparedness aligns with CDIO Standard 2 (Learning Outcomes), advocating balanced learning outcomes in technical knowledge, reasoning, and interpersonal skills. This study emphasizes the impact of students' diverse backgrounds on their readiness, suggesting curricula adapt to varied educational needs. Collaboration relates to CDIO Standard 3 (Integrated Curriculum), promoting an interdisciplinary curriculum that supports teamwork and communication skills crucial to architectural education. The findings highlight collaboration's dual role in enhancing learning while posing challenges. Whereas task design corresponds to CDIO Standard 5 (Design-Implement Experiences), it advocates for curricular structures that integrate theoretical and practical learning. The structured task approach described in this study effectively scaffolds learning, maintains student engagement, and supports skill development. Finally, feedback connects to CDIO Standard 7 (Integrated Learning Experiences), emphasizing constructive feedback to refine students' understanding and abilities. This aligns with CDIO's commitment to continuous improvement and adaptive learning.
However, subtle differences exist. CDIO emphasizes hands-on experiential learning more explicitly, directly linking theory to practical applications. This study suggests that further consideration of workspace and environmental influences is warranted, as students expressed a preference for home environments over classroom settings due to fewer distractions and increased focus. Additionally, demographic factors such as academic background, age, and gender, prominent in this research, are less explicitly addressed in the CDIO framework. Furthermore, the study uniquely emphasizes individual contributions within group contexts, highlighting the need for equitable evaluation - a perspective that complements CDIO's broader collaborative approach. Linking these factors to CDIO 3.0 reveals that architectural education benefits from a structured yet adaptable approach, thereby enhancing student engagement and aligning educational practices with professional standards to provide a comprehensive learning experience.

CONCLUSION

This study provides a framework for understanding and enhancing architectural education. Educators can create more engaging and effective learning environments by addressing openness, task design, feedback, and collaboration. These findings contribute to the development of pedagogical strategies that prepare students for the complexities of architectural practice. The integration of qualitative and quantitative analyses provides a comprehensive understanding of the factors influencing student engagement and performance in architectural education. Openness emerged as a critical driver of engagement and motivation. Students who are receptive to feedback and new ideas perform better and experience higher levels of enjoyment and effort. Task design was another significant factor, with phased and well-structured assignments enhancing clarity and maintaining motivation. On the other hand, poorly designed tasks led to disengagement and diminished autonomy, underscoring the need for a balance between complexity and achievability. Feedback and collaboration were found to be critical in promoting growth and enhancing learning experiences. Clear and constructive feedback helps students refine their work and build confidence, while effective collaboration promotes peer learning and supports the development of critical teamwork skills. However, challenges such as unequal contributions in group projects highlight the need for transparent and equitable evaluation practices.

The findings highlight the importance of creating an inclusive and engaging learning environment that supports the diverse needs of students. Educators should focus on openness, designing manageable yet challenging tasks, providing constructive feedback, and facilitating equitable collaboration. Addressing these factors holistically can enhance individual and group performance, ensuring a more productive and rewarding educational experience.

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