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AIM

The aim of the Journal of Design Studio is bringing different design studio researchers together on a multidisciplinary design studio research platform. This design studio research platform gives the researchers who made experimental studies in their design studio education to share their works with the other researchers in the same area or similar research fields. The scope of the Journal of Design Studios include all research and experimental works realized in all type of design studios.

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Integrated design studio,
Design studio practice,
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Editorial

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Editorial
This issue of the Journal of Design Studio has one book review and seven research, and one design studio case articles. Journal of Design Studio has been started to be indexed by NAVER Academic, and IAD Index of Academic Documents.

"Dreaming of Better Spaces: Environmental Psychology in Students' Redesign of Interior Architecture Studios " by Yaren Sekerci, and Mehmet Ugur Kahraman is the first article in this issue. This research examines how interior design students view and suggest changes for their studio spaces by utilizing environmental psychology principles. The analysis includes the assessment of proposals from 10 student groups, concentrating on spatial organization, practicality, visual appeal, and the emotional influence of the created environments. The study underscores the students' desire for versatile studio spaces that evoke positive emotional reactions and enhance their overall state of happiness.

The second research article, by Firat Kücükersen, Gozde Gokdemir, and Ugur Efe Ucar, is titled "Design Students' Affordance-based Messages in an Undesigned Design Studio". The research was conducted to investigate the correlation between the messages conveyed by students and the opportunities provided by the studio. This was achieved through the utilization of participant observation and photovoice techniques in the classes that were attended within the same physical setting. The researchers identified four key themes - direct message, indirect message, transcendent message, and action without a message - which guided them in exploring and elucidating the opportunities provided by our studio.

Serkan Sipahi and Zeynep Bural are the authors of the third research article which is entitled as "Damage Degrees of Historical Buildings After the Conflict in Diyarbakır Sur District". Diyarbakır's Sur district has faced significant destruction. Despite ongoing restoration efforts, there is still a debate surrounding the effectiveness of the mitigation of damage. This area, which is home to religious, civil, and social structures, has been designated as an urban conservation site. Based on damage assessments carried out by the Ministry of Environment and Urban Planning in 2019, the buildings were categorized as severely damaged, moderately damaged, slightly damaged, undamaged, or lost.

The article which is entitled "Constructional Designs of Architecture Students – Were Building Subsystems Successfully Integrated During the Project Process?" written by Ecem Edis. The lack of proper coordination between building subsystems designed by different specialists can lead to integration issues. In addition to their design responsibilities, architects are often tasked with the responsibility of controlling and coordinating these subsystems to prevent such problems. The Construction Project course in the Bachelor of Architecture Program at Istanbul Technical University aims to provide students with the necessary experience in integrating building subsystems.

Sudipti Biswas, and Dibbendu Saha are the authors of the article which was entitled as "Students' Perspective of Design Studio Assessment: An Experience in Bangladesh". Employing a grounded theory methodology and mixed-method analysis, this paper examines the viewpoint of students on intermediate assessment and final evaluation of design studio courses, specifically desk critique and

jury, through a case study of the Department of Architecture at the Military Institute of Science and Technology, Bangladesh. The study incorporates participant observation of both educators and learners, as well as a questionnaire survey of students. The findings suggest that there may be discrepancies between the perspectives of learners and educators, highlighting the potential for enhancing the studio-based learning program.

The research article was written by Ayorinde Samuel Oluyemi and is entitled as "CAD Inspiration for Design Students on the Geometric Modification of Letters". This study explores geometric modifications in letter design to encourage originality among elementary design students. It emphasizes viewing Computer-Aided Design (CAD) as a tool for boosting students' inspiration and familiarity with innovative letterforms. The combination of CAD and manual techniques notably improves students' intuition and creativity in letter design, with the overall positive impact on their creative output.

Eda Yeyman, Irem Korkmaz, and Irem Naz Kaya are the author of the article which is entitled as "Unfolding the Rhythm: Transmediary Thinking in Design". This article investigates the confluence of sound and space in the context of first-year design education, as illustrated by the "Unfolding the Rhythm" project. Sound is regarded as a dynamic influence that molds subjective perceptions of time and space, establishing imperceptible connections between individuals, objects, and locations. The project records sounds associated with stories of breaking away from everyday life, organizing them into speculative spatial narratives using a digital audio workstation. These auditory narratives are then transcribed into spatial notation drawings, which are further converted into three-dimensional sound topographies within a predefined volume.

Review article written by Aysegul Kidik and Burak Asiliskender which is entitled as “XR Experience in Architectural Design Studio Education: A Systematic Literature Review” examines the use and impact of XR technologies in architectural design studio education, exploring how conventional components can evolve with XR from 2019 to 2024. It focuses on XR's influence on design studio education and experiential learning, guiding students, educators, and researchers at the intersection of XR and architectural design studio education.

Design Studio Case article written by Pinar Koc and Ugur Tuztasi is entitled as "A New Experience for Integration of Section and Model: A Case Report". The purpose of this case report is to illustrate an experience that involved the transition from online education to face-to-face instruction for students, as well as the utilization of the section-model practice by studio tutors. The study seeks to explore the connections between the continuity, disruptions, and changes in architectural design education, with a focus on reintegrating the section and model in the studio.

Book review by Damla Atik about the book “From Tradition to Cittaslow TARAKLI (Gelenekten *Cittaslow* a TARAKLI)”, written by Nevnihal Erdogan, and Hikmet Temel Akarsu, was published by Verita Publication in 2018 is the last article of this issue. The book review makes a comprehensive introduction of the book, which deals with the changes that Taraklı, which has become a slow city, has undergone, starting from its traditional characteristics.

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Dreaming of Better Spaces: Environmental Psychology in Students' Redesign of Interior Architecture Studios

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Abstract: This study looks at interior design students' perceptions and remodeling ideas for their studio spaces through the lens of environmental psychology. It evaluates 10 student groups' proposals, with a focus on spatial layout, usefulness, aesthetics, and the emotional impact of the designed places. Key themes include ergonomic furniture, spatial zoning, color scheme preferences, and the incorporation of natural components. The study emphasizes students' need for multifunctional studio spaces that elicit good emotional responses and improve their sense of well-being. It also highlights the changing nature of interior design education, as students prefer ergonomic seats over stools. The findings highlight the necessity of incorporating students in the design of their learning environments, thereby connecting theory with real-world applications.

Keywords: Environmental Psychology, Human Centered Design, Interior Design, Interior Design Education, Studio Environment.

Introduction

Environmental psychology's study of "Place" and "Sense of Place" provides a comprehensive knowledge of how people interact with their physical surroundings. The term "place" refers to a specific, tangible area, emphasizing its physical attributes and the activities it hosts (Gifford, 2016).

Place attachment, a subcategory of "Sense of Place," refers to the emotional and functional relationships that exist between people and places, on a scale ranging from a district to a country. People create emotional ties based on physical characteristics, social interactions, and cultural influences (Hashemnezhad et al., 2013). The concept of "Sense of Place" encompasses the dynamic process of developing these attachments, which is influenced by personal experiences, social interactions, cultural and historical backgrounds, and environmental features, emphasizing the relationship's individualized and evolving nature (Gifford, 2016). Neuroscience has helped to better understand "Sense of Place" by uncovering neural correlates of phenomenological observations about the term. Perceiving, memorizing, assessing, and applying spatial information all require the use of certain brain structures and processes. This supports the arguments of human geography and environmental psychology (Lengen & Kistemann, 2012).

In architecture and interior design, these terms drive the creation of environments that elicit emotional and meaningful responses from users. Robinson & Pallasma (2015) highlights the importance of sensory and emotional responses in design, incorporating neuroscience ideas to create more human-centered designs. Similarly, Caan (2011) argues that interior design should prioritize creating a comfortable, tactile setting ("Place") while also establishing a dynamic emotional and perceptual interaction between persons and their surroundings ("Sense of Place").

These notions influence how environments are planned and managed in order to improve human well-being. They play an important role in sectors such as urban planning, architecture, and environmental conservation, emphasizing the significance of considering both the physical and emotional components of environmental design (Donald, 2022).

Norman (2007) explains why designs that elicit good emotions are more likely to be favored by consumers. He highlights that an emotional connection to a product can have a substantial impact on user preferences and happiness. This connection stems from the product's ability to engage the user on multiple emotional levels, including visceral, behavioral, and reflective. Products that effectively appeal to these emotional qualities are frequently seen as more desired, resulting in a richer and more favorable user experience. This emotional resonance is critical in determining a design's overall perception and success among its consumers.

When integrating Norman's (2007) concepts of emotional design into interior design, the concept of "Sense of Place" is critical. If a space elicits good feelings in its users, they are more likely to form a deeper connection with it, which improves the sense of place. This emotional tie is based not just on visual appeal, but also on how space serves functional demands while reflecting personal beliefs and cultural characteristics. As users feel good in such a setting, their attachment deepens, and the area becomes more than just a physical location; it becomes an important part of their lives, imbued with personal and emotional value (Norman, 2007; Van Gorp & Adams, 2012; Walter, 2011). "Place attachment" happens when the emotional bond is being provided between people with specific spaces or environments.

The significance of students developing a sense of place attachment to their campuses and classrooms is crucial for enhancing the university experience. Xu et al. (2015) highlight that such attachment fosters academic integration and social well-being, contributing to a more positive experience. This attachment evolves through active engagement and meaningful interactions within the space, as demonstrated by Rioux et al. (2017), who note the importance of exploration and knowledge of the environment in developing a sense of belonging. Similarly, Qingjiu & Maliki (2013) emphasize the role of the campus environment in students' well-being and identity formation, while Moghisi et al. (2015) illustrate how emotional and cognitive connections to the university influence academic motivation and social interactions.

Holton (2014) further underscores the importance of adaptive place attachment during transitions, shaping student identities and social networks, and facilitating adaptation to new and unfamiliar environments. This comprehensive view suggests that place attachment significantly enriches students' university life, highlighting the need for educational providers to create environments that strengthen the connection between students and their educational settings.

Our observations of interior design students at our university reveal an intriguing trend: they increasingly prefer working at coffee shops placed over campus or off campus rather than the studio spaces that have been specifically designated for their use. This alteration in their working space preferences piqued our interest.

The traditional design studio, as explored across a spectrum of studies, serves as the backbone of design education, emphasizing the vital role of hands-on learning and mentorship in fostering

design expertise. Kurt (2009)'s investigation into studio environments emphasizes the apprenticeship model's enduring relevance, highlighting its importance on practice and theory integration as essential components of design education.

This model supports the close interaction between students and instructors, pivotal for the development of design proficiency and critical thinking. Similarly, the study by Casakin and Davidovitch (2013) affirms the traditional studio's effectiveness in creating a rich social-academic climate conducive to collaborative learning and innovation

Kalisperis and Pehlivanidou-Liakata (1998) delineate the representation challenges within traditional studios, arguing that despite advances in digital technologies, the core activities of drawing and modeling remain central to the design process. This adherence to manual techniques underlines the traditional studio's role in teaching students to translate mental visualizations onto the drawing board, a critical skill in architectural design.

Moreover, Erçevik Sönmez (2020)'s exploration of educational approaches within design studios illuminates the structured environment of traditional studios, where instructor-led critiques and discussions facilitate a dynamic learning process. This structured critique process is instrumental in guiding students through the complexities of design challenges.

Furthermore, the contributions of Kahvecioğlu (2007) and Qureshi (2019) to the discourse on traditional design studios reveal the studios' enduring value in fostering creativity and collaboration. Kahvecioğlu (2007) delves into the organizational structures and pedagogical strategies that underpin creativity in the traditional studio setting. On the other hand, Qureshi (2019) examines the collaborative dynamics within the traditional studio environment, illustrating how these spaces serve as incubators for collective creativity and learning in design education.

Together, these works collectively affirm the traditional design studio's crucial role in design education, serving as a foundational platform for developing the complex blend of skills, knowledge, and sensibilities required in the design professions. Through mentorship, collaboration, and hands-on engagement with materials and construction processes, the traditional design studio continues to be a pivotal element in cultivating the next generation of designers.

Coffee shops, as a working environment, offer a markedly different ambiance and set of affordances compared to the traditional design studio environment, presenting an alternative space that caters to diverse learning and creative needs. Yodanis (2006) contends that coffee shops serve as vibrant social spaces, in stark contrast to the frequently isolated and antiseptic studio environs. These spaces create a sensory-rich environment that encourages creativity and collaboration, both of which are necessary for design-related work. Furthermore, Chung (2021) highlights the practical benefits of coffee shops, such as Wi-Fi and power outlets, which appeal to modern students' flexible work habits. These amenities accommodate a variety of work methods and allow for connectivity, which is critical for students working on creative or collaborative projects.

Ferreira et al. (2021) investigate coffee shops' significance in promoting community and social relationships. These places, because of their inclusive and dynamic nature, encourage interactions between disparate groups, adding to a sense of community and belonging. This point is especially important for interior design students, who frequently benefit from peer relationships and collaborative learning environments.

Pozos (2015) highlights the unique amalgamation of public and private spheres within coffee shops, fostering a distinctive social environment. This blend promotes varied social interactions, enhancing the allure of these venues as alternative workspaces. The research emphasizes the influence of social dynamics on

the choice of workspaces, particularly in urban settings.

Waxman (2006) delves into how the physical and social attributes of coffee shops contribute to a sense of place attachment. The ambiance of coffee shops, being both comfortable and aesthetically pleasing, nurtures a feeling of belonging and productivity. This aspect is crucial for interior design students, who often seek environments that not only spur creativity but also provide a sense of comfort and familiarity.

In summary, these studies elucidate that coffee shops embody an ideal mix of social engagement, practical benefits, and a creative milieu. For interior design students, these attributes render coffee shops a compelling substitute for conventional workspaces, offering the necessary flexibility, social connectivity, and creative inspiration for their academic and professional pursuits.

To further understand why interior design students, prefer alternative workspaces over traditional studios, a research on their ideal studio setting is proposed. This study seeks to examine students' common preferences and the factors that influence their decision to work in various settings. The goal is to improve studio spaces in interior design programs by introducing aspects that promote a deeper sense of space attachment among students. By studying their wants and preferences, the study hopes to build studio spaces that are more in line with the conditions that make alternative locations like coffee shops desirable. This technique will aid in the development of studio environments that are more appealing to students, fostering creativity and productivity.

Methods:

Design Project

This project was developed as an assignment, completed over a span of 3 weeks within a 15-week semester. Students were lectured about the “space”, “place”, “sense of place”, “place attachment”, and “emotional design” terms for 2 weeks. Following that, students were tasked with designing the interior design studio environment in which the course was held, as they had envisioned.

The students had frequently experienced the studio where the course was conducted in previous years and also had the opportunity to familiarize themselves with it during the initial weeks of the term. After the completion of lectures, students were first tasked with measuring the dimensions of the classroom utilized for the course to have a better understanding to the dimensions of the space. Subsequently, they were instructed to devise a scaled plan solution in a schematic sense and to create a new studio design in 3D. The critical consideration here was to design a studio environment that, while not significantly reducing student capacity, would enable an emotional connection rather than a logical or functional one; a space where students would enjoy spending the entire day and even prefer over other settings, essentially "Dreaming of Better Spaces." This task was to be undertaken in groups of at least two, with students choosing their partners to facilitate discussion opportunities and the creation of more thoughtfully conceived spaces. The process then continued through critique-based sessions. Students presented their envisioned studio environments before me, as the course instructor, and their peers, who were then encouraged to discuss whether they would find happiness in spending time in these hypothetical studio designs presented by their classmates.

These studio design proposals were created by junior class students from the Interior Architecture and Environmental Design Department at Antalya Bilim University (Turkey) as part of the "Human Factors in Interior Design" course.

Participants

A total of 68 students were enrolled in the course. Students worked on this assignment in groups of 2 to 4 people. 26 studio designs were evaluated by the department instructors at the end of the assignment based on the depth of the SWOT analyses, the originality and the accuracy of the design ideas, the design

proposals quality and suitability for SWOT analyze. Because it was not possible to incorporate all design products in the current study, only 10 designs were chosen. These ten design suggestions have at least one unique approach and are the most complete.

Methodology

This research utilized a five-stage process designed to explore the integration of environmental psychology into the redesign of interior architecture studio spaces by student groups. Each stage was meticulously planned to build upon the previous, ensuring a comprehensive approach to understanding and implementing design principles aimed at enhancing emotional engagement and educational efficacy in studio environments. The five-stage process that the students took in this process is shown in Figure 1.

The first stage involved the formation of student groups within the interior architecture program. These groups were intentionally composed to foster diverse perspectives and collaborative dynamics. Group formation was facilitated through a structured process that considered students' year of study, areas of interest, and previous collaborative experiences to promote effective teamwork and innovation.

Following group formation, each team conducted a SWOT analysis to critically assess the current studio environment. This analysis focused on identifying the strengths, weaknesses, opportunities, and threats related to the physical layout, resources available, and the emotional ambiance of the studio. The aim was to provide a foundational understanding of the existing conditions from which improvements could be envisioned.

In the third stage, groups were tasked with researching and examining interior design studios from other universities that are recognized for their emotionally engaging and aesthetically pleasing environments. This exploration included analyzing spatial layouts, design elements, and the use of materials and colors that contribute to a positive and stimulating educational atmosphere. The goal was to gather inspiration and insights that could inform the redesign of their studio.

Building on the insights gained from the SWOT analysis and the examination of exemplary studios, each group participated in a brainstorming session aimed at generating ideas to enhance the studio environment. This collaborative session encouraged creativity and open discussion, focusing on strategies to make the studio more emotionally appealing, functionally efficient, and aesthetically pleasing. The brainstorming process prioritized ideas that could address identified weaknesses and leverage opportunities to create an inviting and supportive space for learning and creativity. The final stage challenged groups to synthesize their findings and ideas into comprehensive design proposals for the studio. Utilizing 2D and 3D modeling software, students were

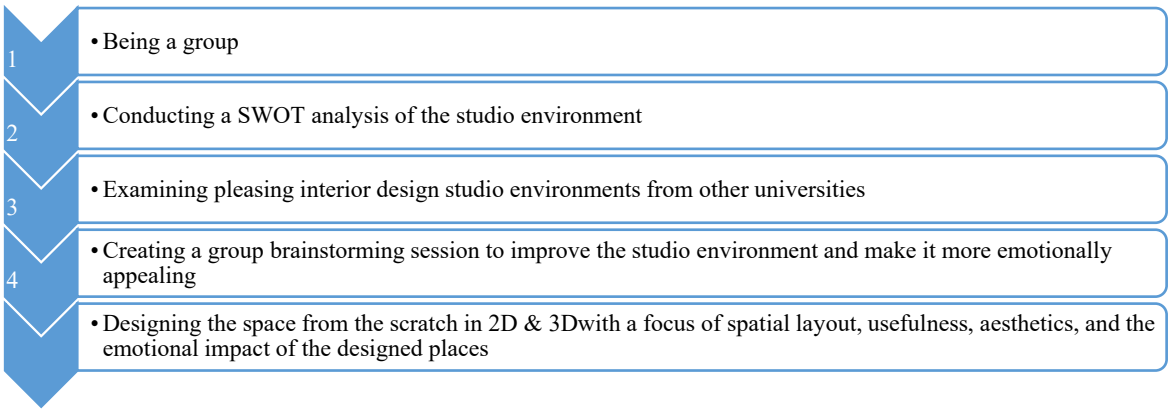


Figure 1: *Students' five-stage process in the assignment*

required to reimagine the studio space, focusing on spatial layout, functionality, aesthetics, and, importantly, the emotional impact of the designed environment. This stage culminated in detailed design presentations that showcased each group's vision for a studio space that not only meets practical educational needs but also fosters a sense of belonging, motivation, and well-being among its users.

By employing this structured five-stage process, the study aimed to capture a holistic view of student-driven design innovations that integrate environmental psychology principles to enrich the studio learning experience. This methodology facilitated a student-centered exploration of how space design can impact emotional engagement and educational outcomes in interior architecture studios.

Findings

The studio setting is placed on the educational building's sub-ground level; yet, because of the level difference, it has windows that provide natural ventilation, outside views, and daylight. The room is spacious enough to accommodate 45-50 students drawing at the same time. With a tighter fit, it can accommodate 60-65 people and drawing tables. The HVAC system works properly, ensuring comfort. There is a projector available for presentations.

The tables are relatively new, but they were quickly worn by students building models during the first term, causing surface damage. The tables are moveable, allowing for flexible rearranging based on varied class needs. There are outlets on the floor, which can cause tripping hazards. This was a necessary tradeoff to allow the tables to move around more easily. The environment exhibits a monochromatic palette; every element, including the furnishings and walls, is rendered in white. The lighting, abundant throughout the space, emanates a cool hue. A whiteboard is present; however, its size is modest relative to the dimensions of the wall and classroom, resulting in infrequent use. Storage is limited, and students are not allotted desks, resulting in a first-come, first-serve seating arrangement. There are no permanent cork or metal boards for students to display their work; panels are hauled in from storage during jury days.

The space contains no level differences. During design studio workshops, instructors typically deliver comments from anywhere, commonly at a student's desk. For theoretical classes, the instructors sit at either the front student desk or the teacher's desk.

The studio encompasses an area of approximately 162 square meters, with dimensions of 14.7 meters (x-axis) by 11 meters (y-axis). Structurally, the space is defined by two parallel columns located 300 cm away from the window side on the x-axis, each measuring 75 cm by 75 cm. The column nearest to both the instructor's desk and the whiteboard is situated 310 cm away from the wall where the whiteboard is mounted on the y-axis, with a distance of 240 cm separating the two columns. This configuration influences the visual and spatial dynamics of the studio, especially in relation to student engagement and visibility. The studio's ceiling height of 450 cm amplifies the sense of spaciousness, enhancing the overall perception of the studio as an open and airy environment. The presence of two double doors facilitates easy access, allowing for fluid movement in and out of the studio.

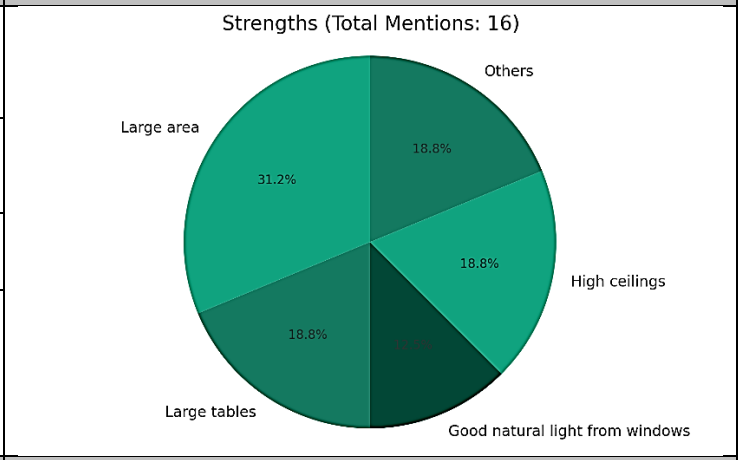
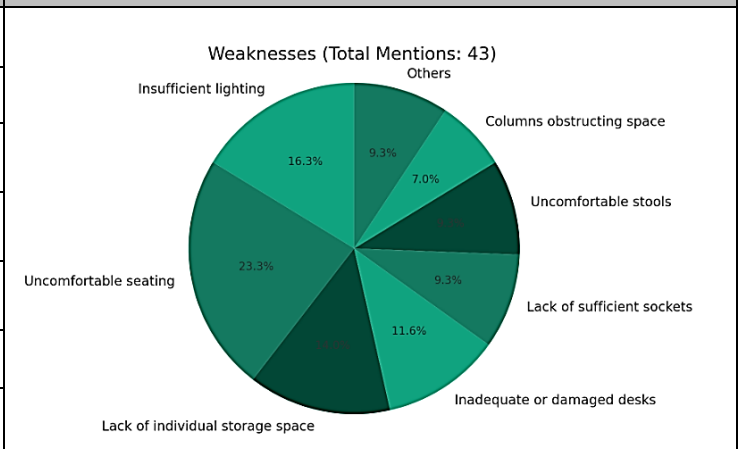
These specific architectural and design features, while contributing to the aesthetic and functional aspects of the studio, also present unique challenges and opportunities for optimizing the learning environment. The placement and dimensions of the columns, for example, necessitate a thoughtful arrangement of seating and working areas to ensure all students have unobstructed views of the instructional space and can participate fully in studio activities.

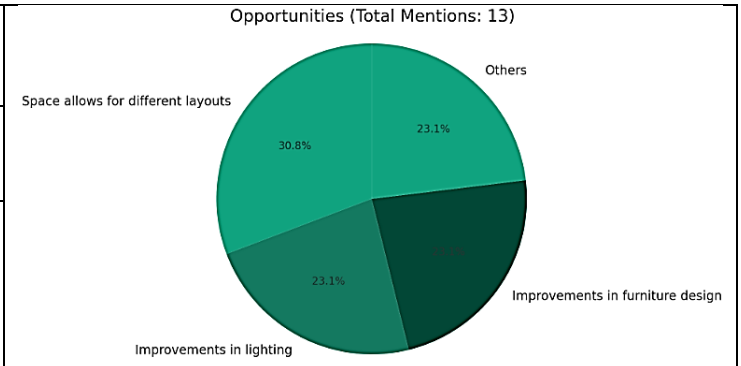
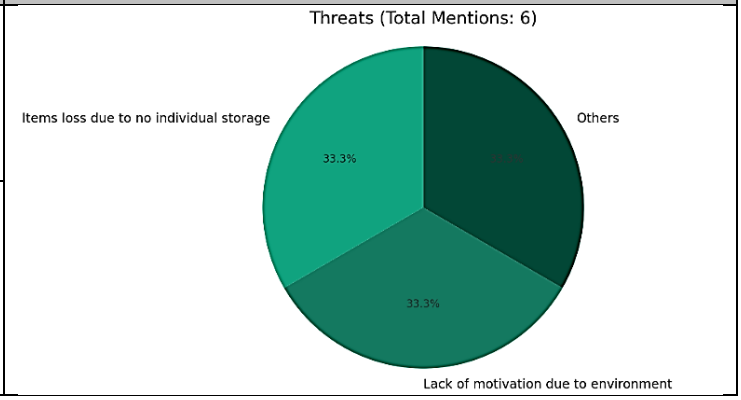
Interior architecture education has historically emphasized manual techniques such as hand drawing and model-making. However, there has been a shift towards incorporating digital tools into the curriculum. This studio is predominantly used by third-year students, at which point their coursework has fully embraced digital methodologies. The studio is

furnished with wheeled stools, which, while facilitating mobility and ease of use for traditional drawing activities, may not provide the ergonomic support needed for prolonged computer use. This situation underscores the evolving needs of interior architecture students as educational focus shifts from traditional to digital design processes.

The student groups were tasked with studying the described studio environment and performing a SWOT analysis. The evaluations of the top ten student groups have been analyzed, and the key issues are presented in Table 1. According to Table 1, the interior architecture studio's key qualities are its spaciousness, which includes wide rooms and high ceilings as well as practical characteristics such as large tables and enough natural light. Conversely, the biggest flaws include uncomfortable seating, insufficient illumination, and a lack of individual storage space, indicating a connection between the current design and the students' ergonomic demands. These findings show that, while the studio has solid basic elements, there is a major need for changes in furniture comfort and practical facilities to better meet student needs.

Table 1: *Summary of student groups' SWOT analyses of the current state of the studio*

Strengths	**Number of Mentions**	
Large area	5	
Large tables	3	
High ceilings	3	
Good natural light from windows	2	
Weaknesses	**Number of Mentions**	
Uncomfortable seating	10	
Insufficient lighting	7	
Lack of individual storage space	6	
Inadequate or damaged desks	5	
Lack of sufficient sockets	4	
Uncomfortable stools	4	
Columns obstructing space	3	
Opportunities	**Number of Mentions**	

Space allows for different layouts	4	
Improvements in lighting	3	
Improvements in furniture design	3	
Threats	**Number of Mentions**	
Items loss due to no individual storage	2	
Lack of motivation due to environment	2	

In order to improve the studio atmosphere for interior design students, an exercise was implemented by the course instructor where students were invited to share their thoughts on the current studio space. The major goal was to determine why they chose not to spend time in the studio and to inspire them to reimagine the space in a way that would elicit pleasant emotions and a desire to stay. By visualizing their ideal studio setting, students were pushed to use their design abilities and ingenuity to make the actual studio more appealing and functional. This activity was designed not only to elicit insightful comments, but also to involve students in a practical application of design concepts, establishing a stronger relationship with their learning environment.

The most commonly suggested notion is "comfortable seating," which reflects students' desire for a more comfortable and ergonomic workplace (Table 2). Other frequent

Table 2: *Students' ideas when redesigning the studio*

Idea	**Number of Mentions**
Comfortable seating	5
Ergonomic furniture	4
Lockers / Storage	3
Flexible layout	3
Bright colors	2
Greenery / Natural elements	2
Technological enhancements	2
Dedicated project/display areas	2
Improved lighting	1
Elevated teaching area	1

suggestions include ergonomic furniture and improved storage choices, demonstrating a desire for utility and comfort in the studio area.

In the conducted SWOT analysis, one of the primary weaknesses identified was the studio's lack of ergonomic seating, which contributed to discomfort among students. The 1st student group directly addresses this concern by proposing the replacement of stools with ergonomic seats, thereby enhancing comfort and potentially improving students' willingness to spend extended periods in the studio. This change aligns with the opportunity to improve the studio's furnishings, directly responding to the students' need for a more comfortable learning environment.

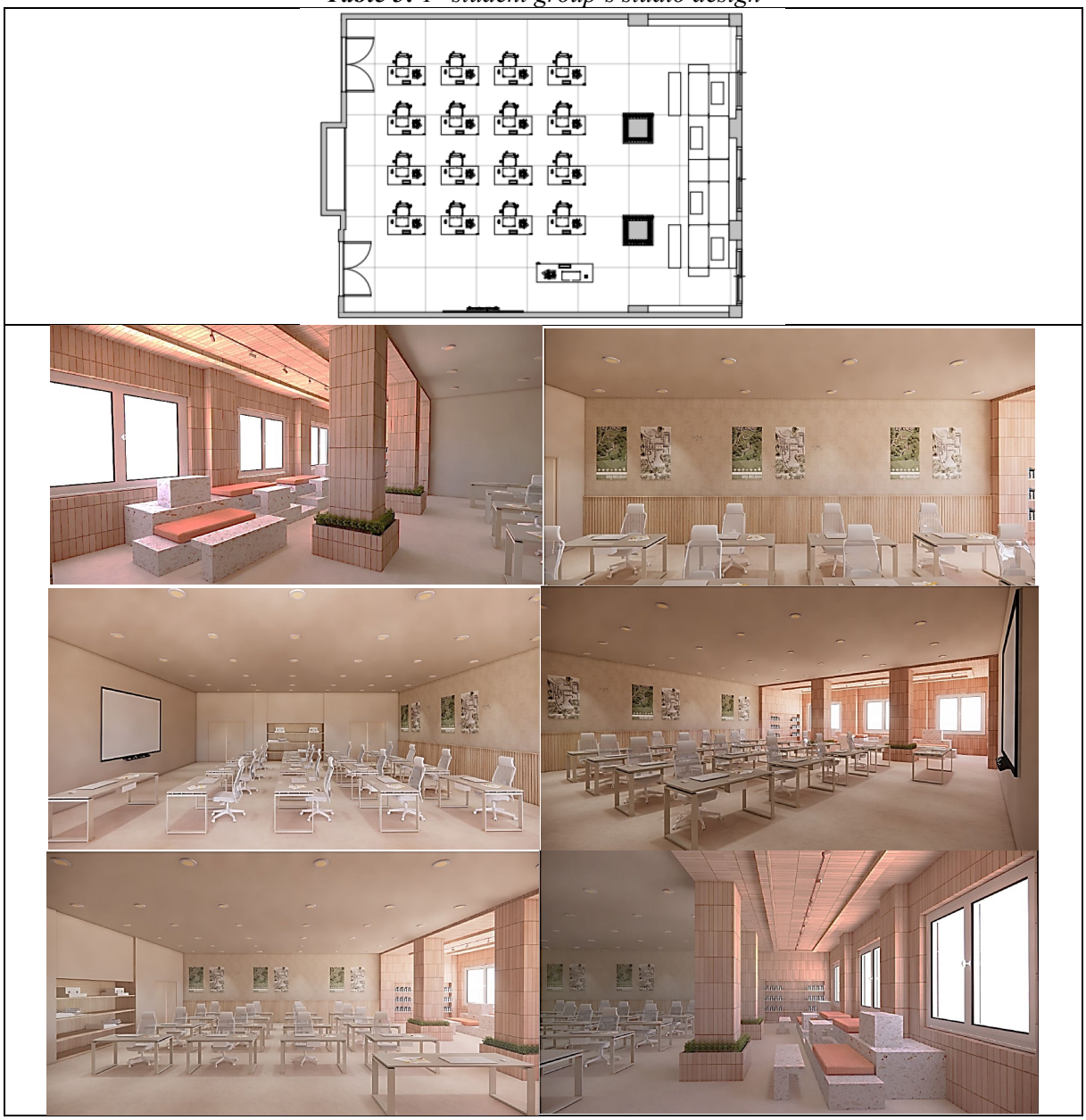
Another critical threat highlighted was the potential for a reduced sense of belonging due to the studio's current impersonal and utilitarian setup. To counteract this, the group suggests introducing warmer hues and indoor plants, thereby creating a more inviting and emotionally engaging space. This approach capitalizes on the opportunity to incorporate natural elements into the studio, fostering a connection to the environment that can enhance well-being and student satisfaction.

Furthermore, the SWOT analysis identified the inefficient use of space and lack of storage as weaknesses within the studio. The student group's concept of dividing the room into two distinct sections for relaxation and instructional purposes not only maximizes the usability of the space but also introduces wall-mounted shelves and cork wall coverings for displaying work. These features offer inventive storage solutions and facilitate the presentation of posters during critiques, directly addressing the need for functional and adaptable storage options within the studio.

Lastly, the encasement of columns in ceramic or similar materials with decorative changes introduces a visually appealing element to the studio, addressing the identified weakness of the studio's aesthetic appeal. This intervention enhances the studio's visual environment, contributing to a more pleasant and stimulating space conducive to creativity and learning.

By systematically matching the SWOT analysis items with the design solutions proposed by the 1st student group, it is evident that their renovation concept thoughtfully addresses key areas for improvement within the studio. This approach not only resolves specific weaknesses and threats identified in the analysis but also leverages opportunities to enhance the studio's functionality and emotional appeal, making it a more desirable space for students to engage in their studies (Table 3).

Table 3: *1st student group's studio design*



The 2nd student group's design concept presents strategic solutions to improve the studio's functionality and aesthetic appeal. Their approach directly responds to the opportunities for enhancing the studio's capacity and storage, while also mitigating identified weaknesses such as uncomfortable seating and the underutilized space between columns and windows.

A critical opportunity identified in the SWOT analysis was the potential to increase the studio's capacity without compromising the quality of the educational environment. By aiming to accommodate more students than the first design concept, this group's plan strategically utilizes the space between the columns and windows for model-making and group work. This decision not only increases the studio's functional capacity but also enriches the educational experience by dedicating space to collaborative activities, addressing the opportunity to foster a more interactive learning environment.

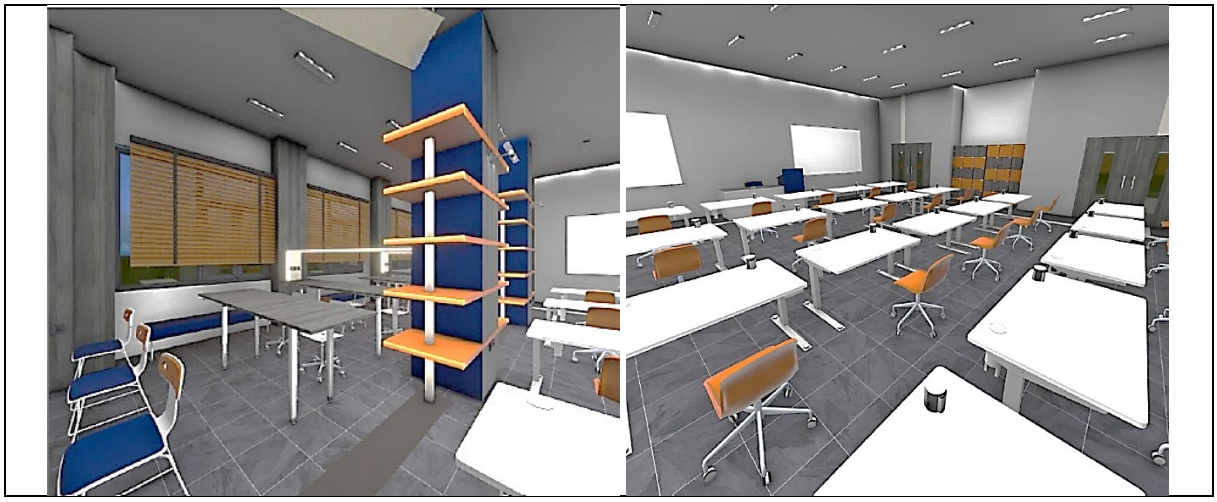
Addressing the weakness of uncomfortable seating, identified in the SWOT analysis, the replacement of stools with ergonomic seats in this design concept directly improves comfort. This change is crucial for supporting students during long hours of work, thereby enhancing their overall well-being and productivity in the studio.

The aesthetic approach of utilizing calm grey tones, complemented by dark navy blue columns and orange-toned chair elements, responds to the need for a visually cohesive and stimulating environment. This color scheme, alongside the incorporation of wooden Venetian blinds and matching shelves and cabinet doors, creates a harmonious and appealing aesthetic. This attention to color and materiality addresses the opportunity to improve the studio's ambiance, making it more inviting and conducive to creativity.

Furthermore, the introduction of closed cabinets as a solution to the studio's storage issue directly tackles the weakness of inadequate storage space identified in the SWOT analysis. This design element provides students with secure and organized storage options, crucial for managing materials and personal items, thereby enhancing the studio's overall functionality.

By specifically aligning their design interventions with the items identified in the SWOT analysis, the 2nd student group's concept effectively addresses key areas for improvement within the studio. Their thoughtful consideration of capacity, comfort, aesthetic appeal, and storage not only resolves identified weaknesses but also capitalizes on opportunities to create a more engaging, functional, and pleasant studio environment for all students (Table 4).

Table 4: *2nd student group's studio design*



The 3rd student group's design concept meticulously addresses specific areas identified in the SWOT analysis, with a keen focus on enhancing the functionality and aesthetics of the studio space. Their innovative use of the area between the columns and windows for leisure, group work, and model-making directly tackles the opportunity to better utilize underused spaces within the studio, promoting a more dynamic and flexible learning environment.

Emphasizing ergonomic comfort, this design's preference for ergonomic chairs over traditional stools responds to the weakness of uncomfortable seating highlighted in the SWOT analysis. This shift aims to improve students' comfort during extended periods of work, aligning with the need for a more accommodating and student-friendly environment.

The decision to maintain the ceiling and lighting design, as well as the window blinds from the original setup, suggests a strategic choice to preserve elements that were already well-received, addressing the strengths mentioned in the SWOT analysis regarding natural light and the effective ambient conditions of the studio.

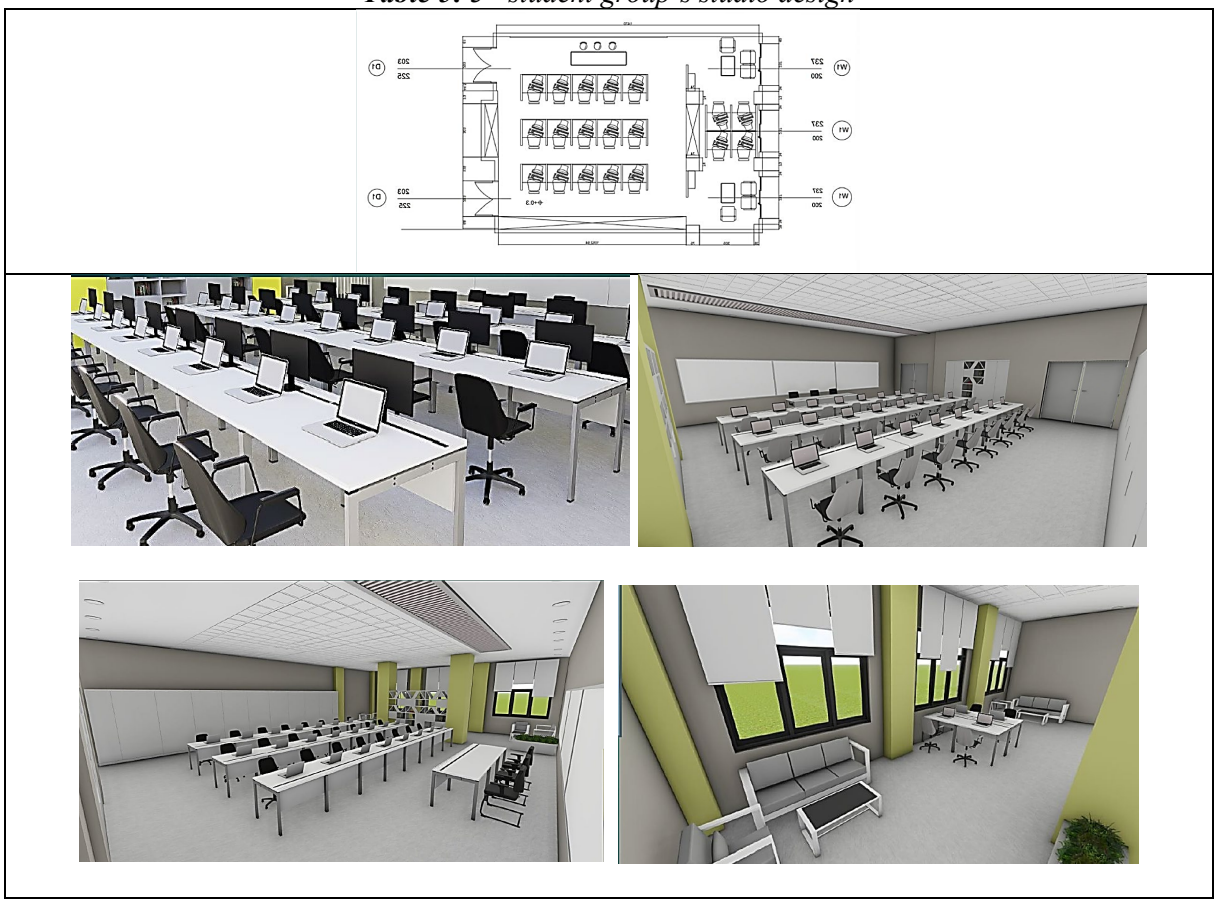
Incorporating light colors for the columns and grey-white tones for other parts of the studio not only refreshes the studio's visual appeal but also creates a more inviting and pleasant space. This choice of palette enhances the studio's sense of openness and supports a positive emotional environment, directly engaging with the opportunity to improve the studio's aesthetic and emotional appeal.

Significantly, the introduction of an increased amount of closed storage in this design addresses a critical weakness identified in the SWOT analysis related to the lack of individual storage space. This solution provides a practical and organized way for students to manage their materials and personal belongings, directly contributing to the functionality and efficiency of the studio space.

Furthermore, the adaptation of the teacher's desk to accommodate multiple instructors reflects a thoughtful approach to the studio's instructional needs, especially during critical activities like juries. This design consideration ensures that the space is equipped to support the collaborative and evaluative aspects of the design education process, directly responding to the opportunities for enhancing the studio's instructional capabilities.

Overall, the 3rd student group's design concept effectively leverages the insights from the SWOT analysis to propose a comprehensive renovation that addresses key functional, aesthetic, and ergonomic needs of the studio. By thoughtfully integrating these elements, the design fosters a more engaging, comfortable, and productive environment for both students and instructors (Table 5).

Table 5: *3rd student group's studio design*



The 4th student group's studio design thoughtfully addresses several key points from the SWOT analysis, particularly focusing on the preservation of traditional hand drawing methods within the studio environment. Their design contrasts with the increasing digital orientation of interior architecture education by emphasizing manual drawing skills, thereby catering to the strengths of traditional learning methods mentioned in the SWOT analysis.

This group's decision to retain stools, while integrating adjustable, mechanism-equipped drawing tables, directly engages with the opportunity to support diverse learning and working styles within the studio. Each table's individual lighting setup enhances functionality and comfort for hand drawing activities, addressing the weakness of insufficient lighting identified in the SWOT analysis.

Designating the space between the columns and windows for socialization introduces a novel approach to utilizing underexploited studio areas. The incorporation of circular column cladding and pouf seats creates an inviting communal space, addressing the opportunity to foster a more collaborative and interactive studio environment, as highlighted in the SWOT analysis.

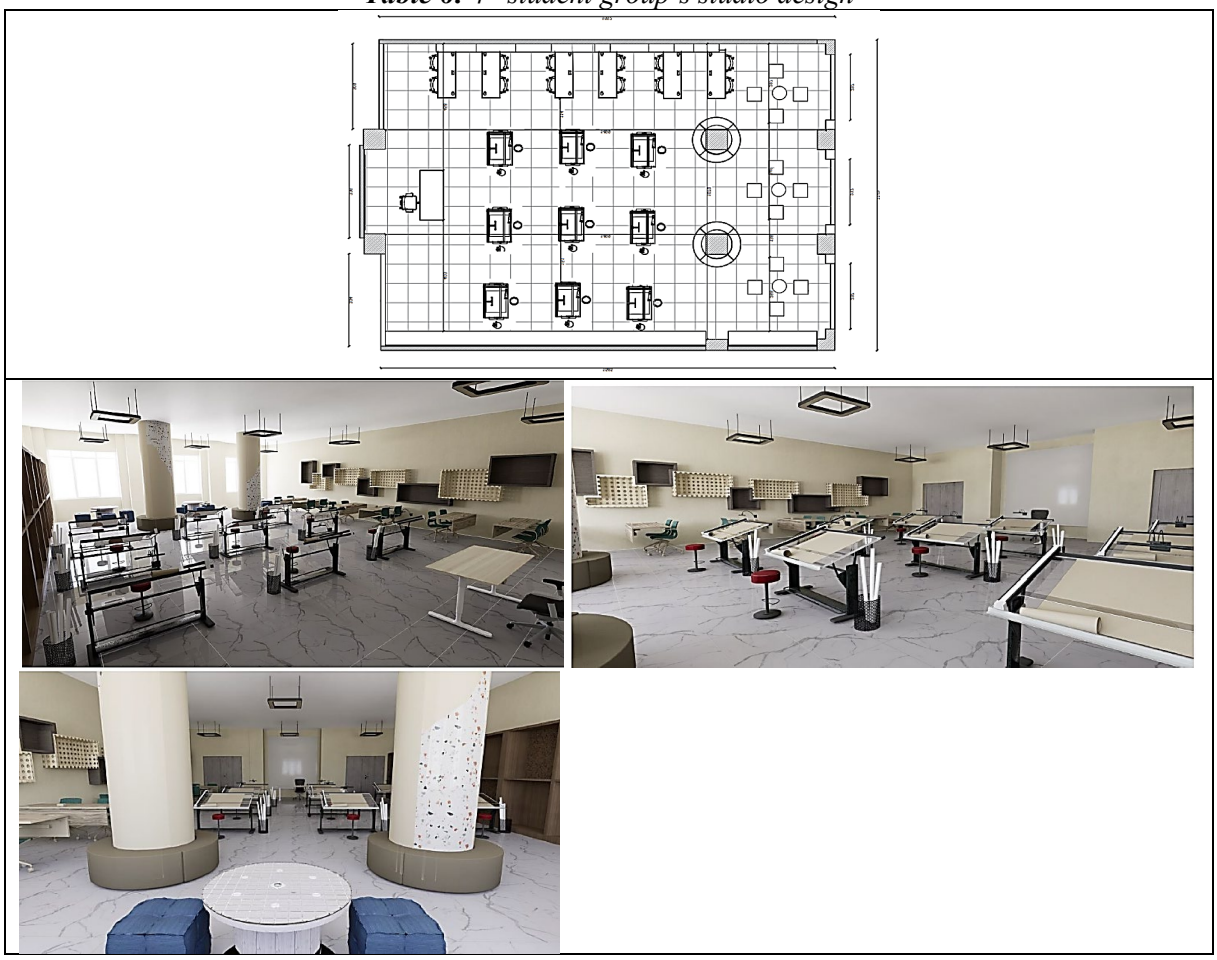
The establishment of model display areas and the inclusion of open storage containers respond to the identified need for more effective storage and display solutions within the studio. This approach not only improves the studio's organizational efficiency but also enhances its aesthetic appeal by showcasing student work, directly tackling the weakness related to the lack of display and storage facilities.

By opting for a color palette of warm and soft tones, the fourth group creates a visually

appealing and comfortable studio atmosphere. This choice addresses the opportunity to improve the studio's ambiance, contributing to a more positive and engaging learning environment that supports both the emotional and practical needs of students.

Overall, the 4th student group's design uniquely addresses the SWOT analysis by prioritizing traditional drawing methods and enhancing the studio's social and functional spaces. Their proposal offers a balanced approach that preserves essential aspects of interior architecture education while innovatively addressing identified opportunities and weaknesses within the studio environment (Table 6).

Table 6: *4th student group's studio design*



The 5th student group's design proposal thoughtfully addresses several key findings from the SWOT analysis, presenting solutions aimed at enhancing both the functionality and aesthetic appeal of the studio environment. By segregating the area between the columns and windows from the main instructional space for group projects and model-making, this design effectively utilizes previously underused sections of the studio, directly responding to the opportunity for improved spatial utilization identified in the SWOT analysis.

Opting for ergonomic chairs over traditional stools aligns with the identified weakness of uncomfortable seating, showcasing a commitment to enhancing student comfort and well-being during studio hours. This choice underscores the importance of ergonomic

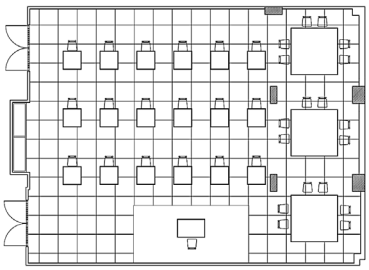
furniture in fostering a conducive learning and working environment.

The introduction of unique open-shelf storage units for each table addresses the SWOT analysis's highlighted lack of individual storage space, offering a practical and accessible solution for students' storage needs. This innovative approach not only improves the studio's organizational capabilities but also promotes a clutter-free and efficient workspace. Characterized by cool tones, cold lighting, and grey surfaces, the design's color scheme and lighting choices contribute to a distinct and modern aesthetic. This decision reflects a strategic effort to create an inviting and stimulating studio atmosphere, directly addressing the opportunity to enhance the studio's visual and emotional appeal.

Furthermore, the incorporation of general storage units, openly shelved and positioned along the studio walls, tackles the identified storage issues within the SWOT analysis. This addition provides ample and versatile storage options, further enhancing the studio's functionality and accommodating a broader range of student needs and activities.

Overall, the 5th student group's design proposal demonstrates a comprehensive understanding of the studio's current limitations and opportunities, as identified in the SWOT analysis. By proposing targeted interventions that address comfort, storage, spatial utilization, and aesthetic enhancements, this design concept offers a well-considered approach to reimagining the studio environment, making it more aligned with the needs and preferences of its users (Table 7).

Table 7: *5th student group's studio design*



The 6th student group's design concept presents a thoughtful consideration of the SWOT analysis by offering solutions that cater to the studio's spatial dynamics and ergonomic needs while enhancing the aesthetic appeal. This design distinctively opts for a warm color scheme, diverging from the cooler tones preferred by the previous group, directly addressing the opportunity to create an inviting and emotionally engaging studio environment.

By choosing not to assign a new function to the space between the columns and windows, the design emphasizes the importance of open, flexible areas within the studio, potentially addressing the threat of a rigid and underutilized space highlighted in the SWOT analysis. Instead, the introduction of storage containers in this area cleverly divides the space, improving organization and addressing the weakness of inadequate storage facilities identified in the analysis.

The replacement of stools with ergonomic seats is a strategic response to the identified weakness of uncomfortable seating, ensuring that the studio supports students' physical well-being during long hours of work. This shift towards ergonomic furniture aligns with the broader trend in interior design education towards creating environments that prioritize students' comfort and health.

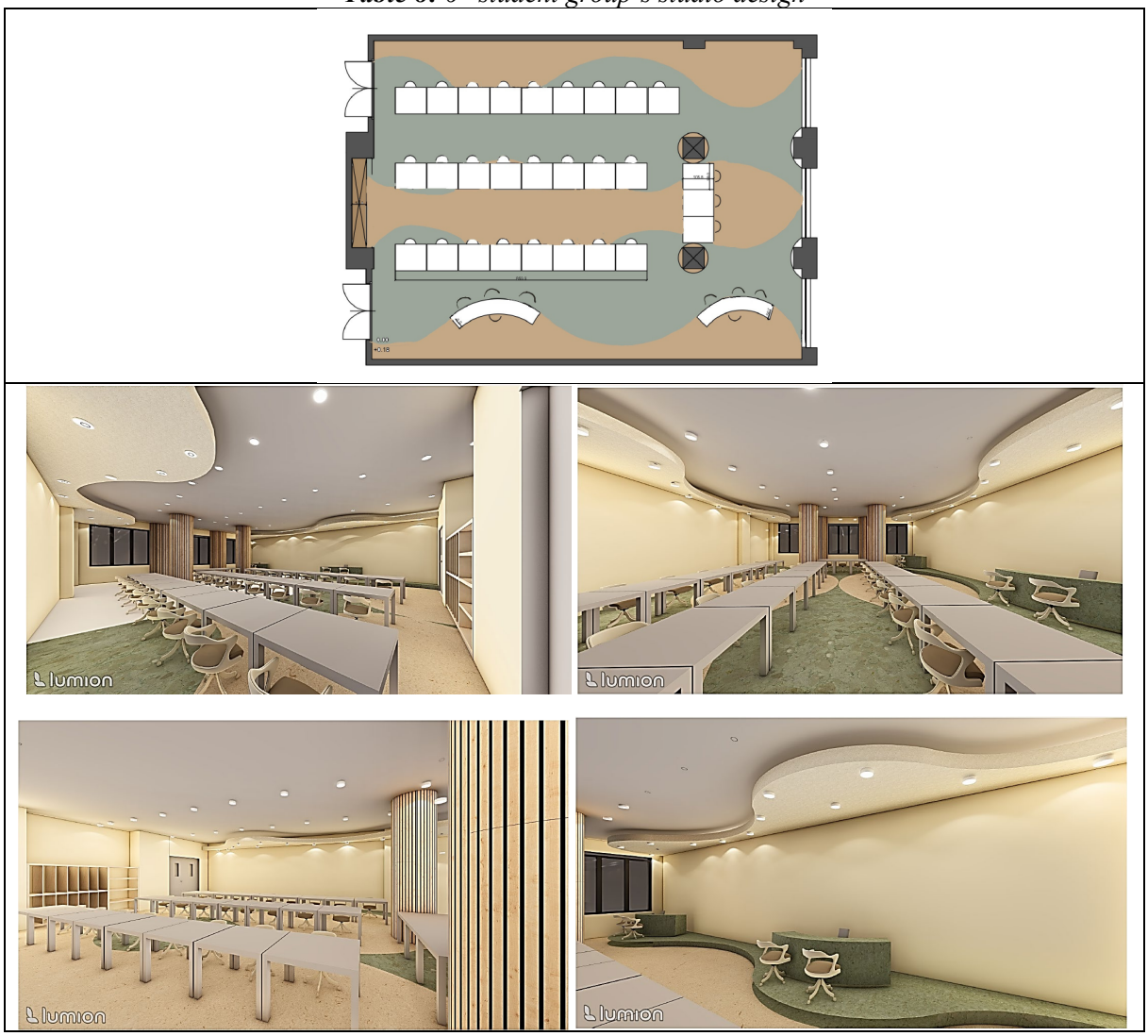
Incorporating elevation differences to delineate instructor areas introduces a hierarchical structure that enhances the studio's functionality for critique sessions, directly responding to the opportunity to optimize the studio for instructional purposes. This design element ensures that the studio accommodates the collaborative and evaluative aspects of architectural education effectively.

The aesthetic treatment of the columns with round wooden panels and the use of green tones throughout the studio not only addresses the opportunity to improve the studio's visual appeal but also contributes to creating a natural and comfortable atmosphere. This choice resonates with the SWOT analysis's identification of the need for a more aesthetically pleasing and emotionally resonant studio environment.

Furthermore, the proposal of open storage units along the walls directly tackles the SWOT analysis's highlighted weakness regarding the lack of adequate storage solutions. This innovative storage approach enhances the studio's usability and organizational efficiency while maintaining visual openness and integrity.

Overall, the 6th group's design concept thoughtfully addresses key areas identified in the SWOT analysis, offering solutions that enhance the studio's ergonomic, functional, and aesthetic qualities. This holistic approach ensures that the studio not only meets the practical needs of its users but also fosters an environment conducive to creativity, collaboration, and well-being (Table 8).

Table 8: *6th student group's studio design*



The 7th student group's design uniquely addresses the opportunity to optimize the utilization of space between the columns and windows, identified in the SWOT analysis. By isolating this area with glass and a metal frame for sound isolation, the group effectively creates a dedicated zone for group model creation and printing facilities. This innovative separation enhances the studio's functional diversity without compromising the instructional area's integrity, directly responding to the need for multifunctional spaces that support various activities.

Addressing the weakness of inadequate individual storage space, highlighted in the SWOT analysis, this group introduces closed wooden storage units within the instructional space. This solution provides secure and organized storage for students, significantly improving the studio's functionality and addressing one of the critical areas for improvement identified in the SWOT analysis.

The replacement of stools with ergonomic black seats is a strategic response to the SWOT finding regarding uncomfortable seating. This design choice prioritizes student comfort and well-being, aligning with the broader objective to create a more ergonomic and student-friendly learning environment.

Furthermore, the decision to paint the walls in warm, off-white tones directly addresses the

opportunity to enhance the studio's visual and emotional appeal, as identified in the SWOT analysis. This color choice contributes to a light and inviting atmosphere, fostering a positive emotional response and a stronger sense of place attachment among students.

By integrating open storage units alongside advanced facilities like a plotter and a beverage vending machine, the design also capitalizes on the opportunity to introduce practical amenities that support students' work and well-being. This approach not only improves the studio's overall usability but also demonstrates a thoughtful consideration of students' daily needs and preferences.

Overall, the 7th student group's design thoughtfully addresses key areas identified in the SWOT analysis by enhancing the studio's functionality, comfort, and aesthetic appeal. Through strategic spatial division, ergonomic improvements, and the introduction of practical amenities, this design proposal effectively transforms the studio into a more engaging, accommodating, and pleasant environment for both individual and collaborative work (Table 9).

Table 9: *7th student group's studio design*

The 8th group's studio design presents a distinctive approach by implementing a tiered layout method, directly targeting the opportunity to improve the studio's spatial organization. This innovative solution addresses the threat of disarray in studio spaces by constraining table movement to lateral directions within a specified height range, thus maintaining order while still offering flexibility in space usage.

The choice to employ warm hue tones and circular shapes, utilizing a vibrant color palette of purple, pink, navy blue, and green, responds to the need for a more visually stimulating and emotionally engaging studio environment, as identified in the SWOT analysis. This design element aims to create a youthful and joyful atmosphere, enhancing the studio's appeal and potentially increasing students' motivation and creativity.

Transforming the space between the columns and windows into a fixed seating and individual work or reading area tackles the weakness of underutilized spaces within the studio. This modification increases the functional diversity of the studio, ensuring that all areas contribute positively to the students' educational experience.

However, the design's limited adherence to accessible and human-centered design principles represents a missed opportunity to fully address the SWOT analysis's emphasis on creating inclusive and ergonomically supportive environments. Future redesigns could benefit from incorporating features that accommodate a wider range of student needs, including those with physical disabilities.

The application of soft off-white or beige on the walls, coupled with wooden floors and furnishings, aligns with the opportunity to utilize natural materials and colors to foster a more welcoming and comfortable learning environment. The inclusion of green-colored storage containers further adds to the studio's functionality, addressing the identified weakness of insufficient storage while maintaining the aesthetic coherence of the design.

Overall, the 8th group's design proposal thoughtfully addresses several key areas identified in the SWOT analysis by enhancing the studio's visual appeal, spatial organization, and functionality. While its innovative approach significantly improves the studio environment, further consideration of accessibility and human-centered design principles could enhance its effectiveness and inclusivity (Table 10).

Table 10: *8th student group's studio design*

The 9th group's studio design adeptly addresses specific elements highlighted in the SWOT analysis, particularly focusing on the utilization of the space between the columns and windows and improving ergonomic support within the studio. By opting to differentiate this area through material change—introducing terracotta-colored flooring—instead of structural separation, this design directly tackles the opportunity to enhance the studio's spatial dynamics and functionality. This approach allows for a seamless integration of diverse activities within the studio, fostering a more versatile and engaging learning environment.

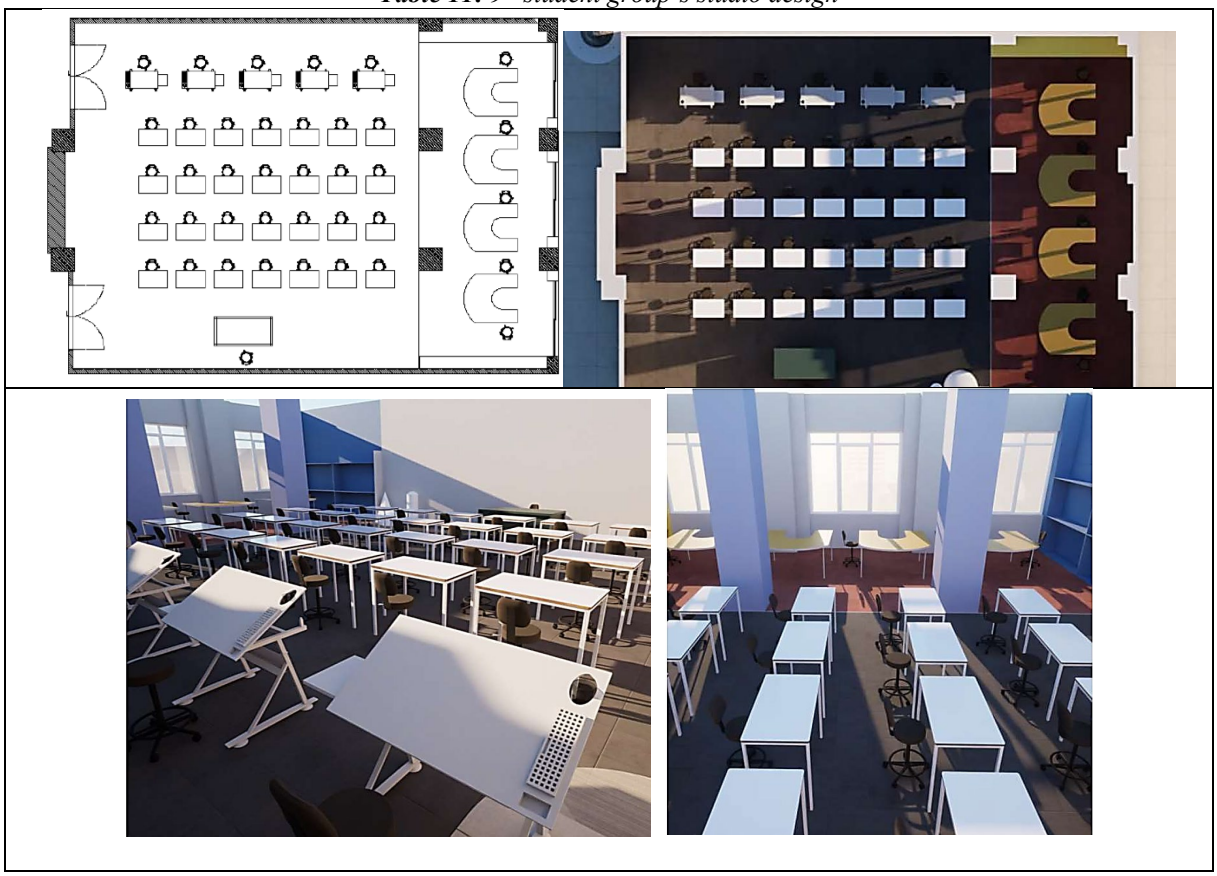
Embracing ergonomic chairs over stools addresses the identified weakness of uncomfortable seating in the SWOT analysis. This shift not only enhances comfort for students engaged in prolonged periods of work but also aligns with the broader objective of creating a more student-friendly environment that supports their physical well-being.

The introduction of tables with adjustable angles for drawing caters to the specific needs of design students, offering the flexibility required for various tasks from hand drawing to digital work. This design choice directly responds to the opportunity for the studio to better support the diverse working styles and preferences of its users.

Moreover, the design's color and material strategy, which incorporates warm orange-pink tones for storage units and light blue for columns, alongside distinct flooring colors for different sections of the studio, strategically improves the space's visual appeal and navigability. This thoughtful use of color not only enhances the studio's aesthetic but also aids in distinguishing between various functional zones within the space, creating a more organized and visually cohesive environment.

However, while this design introduces several innovative solutions to improve the studio's functionality and aesthetic appeal, it remains crucial to ensure that these modifications also consider all students' accessibility and inclusivity needs. The thoughtful application of ergonomic furniture, combined with strategic layout and color choices, illustrates a significant step towards addressing the SWOT analysis findings by creating a more engaging, comfortable, and functional studio space (Table 11).

Table 11: *9th student group's studio design*



The 10th student group's studio design endeavors to enhance the educational environment by creating a hierarchical structure, a method reflecting an attempt to improve instructional delivery and visibility. This approach, however, presents potential accessibility concerns, emphasizing the necessity for inclusive design solutions that accommodate all users, including those with physical limitations, addressing a critical oversight in the original studio layout.

This group's preference for ergonomic chairs over traditional stools directly tackles the identified weakness of uncomfortable seating, promoting a more comfortable and supportive setting for extended periods of work. This change aligns with ergonomic principles, aiming to enhance students' physical well-being and engagement.

The implementation of adjustable tables offers flexibility in drawing and design work, catering to the diverse needs of studio activities. This feature addresses the opportunity for adaptable furniture that supports both traditional hand drawing and digital design processes, reflecting a nuanced understanding of the studio's functional requirements.

Employing warm off-white tones and natural wood materials in both the elevated instructor's area and the studio columns, the design introduces a calming and inviting aesthetic. This choice responds to the SWOT analysis's suggestion to improve the studio's visual appeal, utilizing color and material to create a more engaging learning atmosphere.

The innovative use of space between the columns and windows, distinguished by green colors and movable poufs, offers a flexible and informal area for individual work, effectively utilizing underexploited spaces within the studio. This design decision enhances the studio's versatility, directly addressing the need for multifunctional areas that support a range of activities.

Incorporating open wooden shelves for storage and providing corkboards in individual work areas for poster display directly addresses the identified lack of adequate storage and display spaces. These solutions not only improve the studio's organizational capabilities but also encourage personalization and visual communication among students.

Overall, the 10th group's design proposal thoughtfully addresses several key concerns highlighted in the SWOT analysis, offering a comprehensive approach to reimagining the studio space. By focusing on ergonomic improvements, aesthetic enhancements, and functional flexibility, this design significantly contributes to creating a more inclusive, comfortable, and stimulating educational environment (Table 12).

Table 12: *10th Student Group's Studio Design*

Conclusion

This study's exploration into the redesign of interior architecture studios, guided by the principles of environmental psychology and the innovative ideas of Norman (2007), has revealed a significant trend towards creating multifunctional and emotionally engaging environments. The structured five-stage process undertaken by student groups not only fostered a deep understanding of the current studio settings through SWOT analyses but also inspired a comprehensive examination of

exemplary studios and collaborative brainstorming sessions aimed at reimagining these spaces.

The consistent theme across the student proposals highlights a departure from traditional studio designs that prioritize functionality alone. Instead, there is a clear preference for spaces that support a broad spectrum of activities- ranging from academic tasks to social interactions and leisure. These redesigned environments are envisioned to foster not just efficiency and productivity but also emotional connections, enjoyment, and a diverse array of experiences. This approach aligns with the emerging paradigm in interior design education, which acknowledges the significant impact of spatial aesthetics and emotional resonance on student well-being and creativity.

The proposals emphasize the importance of ergonomic furniture, the inclusion of natural elements, and the thoughtful use of color and material to create inviting and stimulating spaces. Such design decisions are directly responsive to the insights gleaned from the initial stages of the methodology, specifically the SWOT analysis and the examination of successful studio environments. For example, the ergonomic chairs over traditional stools reflect a commitment to comfort and physical well-being, while the strategic color choices and material use aim to enhance the emotional ambiance of the studios.

Moreover, the inventive storage solutions and the flexible spatial layouts proposed by the students demonstrate an acute awareness of the need for adaptable and user-centered design. This reflects a sophisticated understanding of how environmental psychology principles can be applied to create spaces that are not only functional but also supportive of the diverse needs and preferences of their users.
In sum, the findings from this study emphasize the vital role of student participation in the co-creation of their learning environments. By actively involving students in the design process, educational institutions can ensure that studio spaces not only meet the evolving demands of interior design education but also resonate with the students on an emotional level. The student-led redesigns presented in this study offer a vision for future studio environments that are characterized by flexibility, emotional engagement, and a holistic approach to educational space design. These insights contribute to the broader discourse on the importance of integrating environmental psychology into the design of educational settings, highlighting the profound impact such an integration can have on enhancing the quality of the educational experience.

Limitations

This study, while offering valuable insights into the integration of environmental psychology in the design of interior architecture studios, is not without its limitations. One of the primary constraints lies in the subjective nature of assessing emotional responses to spatial environments. Emotional engagement and the sense of belonging are inherently personal experiences, influenced by a myriad of individual factors, including past experiences, personal preferences, and even the day's mood. As such, the interpretations of what constitutes an emotionally engaging or comforting space can vary widely among individuals. This subjectivity presents challenges in generalizing the findings and applying them uniformly across different educational contexts.

Furthermore, the study is situated within the specific context of a single university setting, which may limit the applicability of its conclusions to other institutions with different architectural layouts, cultural backgrounds, or educational philosophies. The unique characteristics of the participating university, including its spatial configurations, student demographics, and curricular priorities, might influence the design proposals generated by the students and their perceptions of what makes an effective studio environment.

These limitations underline the need for caution in extrapolating the study's findings to broader contexts. Future research could address these constraints by incorporating a more diverse

range of university settings, employing quantitative measures to complement qualitative assessments of emotional responses, and exploring the interplay between individual differences and spatial perceptions in educational environments.

By acknowledging these limitations, this study opens the door for future research to further refine our understanding of how design principles rooted in environmental psychology can enhance the educational experiences of interior architecture students. Expanding the research to include a wider variety of educational settings and incorporating more objective methods for evaluating emotional engagement with space could provide a more comprehensive and nuanced understanding of the role of studio design in supporting learning and creativity.

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Design Students' Affordance-based Messages in an Undesigned Design Studio

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Abstract: In this study, as PhD candidates and teaching assistants working in the Interior Architecture Department of the Faculty of Architecture at Istanbul Technical University (ITU) we aimed to explore the interrelationship between the students' messages and the studio's affordances by using participant observation and photovoice methods in the classes we attended in the same physical space. We used the photographs taken by us during the studio courses as the central data set to explore the messages triggered by the studio affordances, which are formed based on the complex environments and relationships created by the limited physical facilities of our design studio, the high student quotas and the large project groups using the same physical space at different and even the exact times. Through collaborative commentary and reflective writing, we produced written and visual reports on the final themes at the conclusion of the analysis process. Finally, we concluded that the four main themes, namely, direct message, indirect message, transcendent message, and no message but action, guided us in exploring and explaining our studio's affordances.

Keywords: Interior design, Design studio, Affordance, Participant-observation, Photovoice.

1.Introduction

The studio's long tradition of diverse pedagogical practices, which officially began in 1819 at the Ecole des Beaux-Arts in France and later spread to European countries and North America, is considered an essential component – even the cornerstone – of design education (Demirbaş & Demirkan, 2007; Friedman, 2002; Goldschmidt et al., 2010; Kauppila, 2018; Ochsner, 2000). Designing and learning to design are two challenging tasks at the heart of the studio, and few students can complete the studio requirements without experiencing dilemmas. Sachs (1999) defines this situation as 'stuckness'. The complex nature of the social interactions in the studio (Sawyer, 2019), the difficulties experienced in constructing knowledge, and the influence of environmental factors become part of design education and studio life and culture. In fact, the learning and development that takes place means transitioning from one habitus to another as a struggle (Çil & Demirel-Özer, 2021).

Within this specific scope, we have opened discussions for relationships between design students and studio affordances. According to the affordance theory, which is based on the contextual and situational possibilities of the individual's relationship with the surroundings,

the environment offers actions and scenarios that are susceptible to change and transformation, as well as physically visible relationships (Costantini et al., 2010; Gibson, 1979/2014; Rands & Gansemer-Topf, 2020). Hence, when there are no objects or arrangements to meet the needs of individuals in spaces, this deficiency leads them to find solutions (Kim, 2021), in other words, to create new affordances. In the context of our research, the messages and other responses that students produce as a solution to their difficulties due to their inability to personalise their workspaces because of the technical and spatial constraints in the studio reveal new affordances in the studio.

As authors working in the same physical space and as stakeholders in design education in a complex and undesigned design studio, we were able to closely observe our students' actions and responses towards studio affordances. One of the authors worked in a foundation design studio consisting of Architecture, Interior Architecture, and Industrial Design students, professors, and research and teaching assistants. In the studio, the following were held on three half days, 12 hours in total per week: Project I course consisted of a total of 75 students and Visual Communication II: Visualization & Perspective course consisted of a total of 71 first-year students. The second author participated in the Interior Architecture Design Studio III course, which takes place in a second- and third-year (vertical studio) of interior architecture education, conducted over two half days, 8 hours in total per week. There were 22 second-year students and 4 third-year students in the class. The final author was involved in the Interior Architecture Project II course of the International Master of Interior Architectural Design (IMIAD), which mostly took place on one half-day, 4 hours in total per week in the studio. There was a total of 15 master's students in this international class (Figure 1).

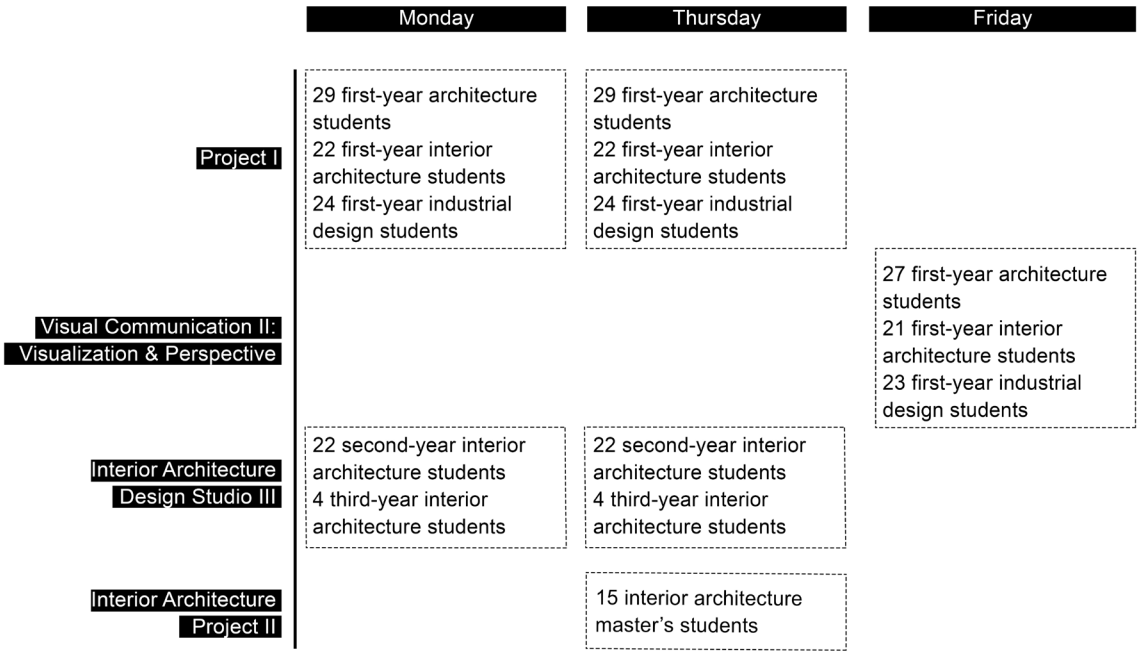

Figure 1: *Participants in the design studio*

Consequently, we had the opportunity to observe our studio in detail with a wide range of activities as it was utilised by students at various levels – first-year, second-third-year, and master's students. The diversity in student usage patterns allowed us to gain insights into the different ways and times in which the space was experienced. However, there was no significant difference between the various educational levels we observed in our design studio. In regard to the conditions, the primary objective of the study was to produce thick descriptions (Geertz, 1973) based on the ethnographic approach, which is defined as "a qualitative description of human social phenomena (Austerlitz, 2007 p. 171)", by documenting and interpreting the explicit and implicit relationship between the affordances in the design studio and the students from various years.

In line with the literature, we used the photovoice method that has become increasingly common over the years, which was designed to reach marginalised groups and serve as their voice. Even though it is not widely used in higher education research (Wass et al., 2020), this method was defined by Harrietha et al. (2023) as "an instructional tool" (p. 3) and "a longstanding pedagogical tool" (p. 4). As academics working in the same interior architecture department and as researchers employing this systematic methodology, we regularly met to discuss our data. At the conclusion of the 14-week academic term, we individually analysed our data, identified some preliminary themes, and then synthesised them through collaborative group discussion to arrive at our final themes, namely, direct message, indirect message, transcendent message, and no message but action, to comprehend and explain the affordances of the design studio through the students' messages.

This paper is constructed into five fundamental sections. Following the general framework of the study in the introduction, the theoretical foundation section provides a brief review of the literature on relationships between the design studio and the notion of affordance and photovoice, which was employed as a data-collection method through participant observation roles. Then, we delve into the case of the "undesigned design studio" while providing detailed information about it. The findings section presents the final themes derived from our observations, discussions, and syntheses. Finally, in the conclusion section, we discuss the results obtained from the application of the photovoice and our reflection on this method as the practitioners in an undesigned design studio and present future research directions (Figure 2).

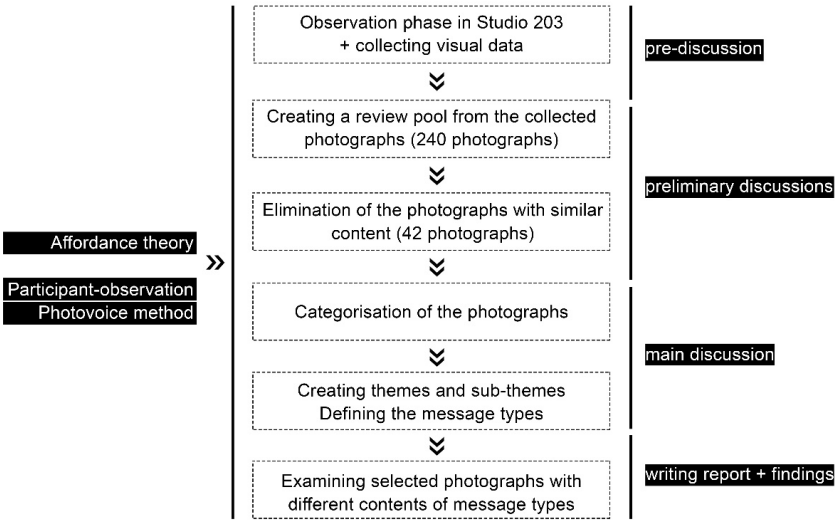

Figure 2: *Phases of the research study*

2.Theoretical Foundation: Design Studio and Affordance

Based on the notions of field theory and life space, the position of the learner in a learning space defines their reality so that knowledge is constructed not only by the cognitive functions of the individual but also by the influence of educational environments' physical and social components (Kolb & Kolb, 2005; 2009; Kolb, 2015). Given the impact of the physical characteristics of the academic environment on students' attitudes, behaviours, and learning, it is inevitable that spatial opportunities and constraints will reveal a variety of social and cognitive relationships in this context. Furthermore, physical learning environments become an integral part of the learning journey by allowing the emergence of mental and social environments that encourage students to collaborate and learn from one another (de Borba et al., 2020; Rands & Gansemer-Topf, 2017; Vyas et al., 2013).

Across the literature, the physical learning environment is evaluated in light of the affordance theory, which mainly defines/includes its qualitative characteristics (Rands & Gansemer-Topf, 2020). It is probably safe to say that the affordances of the environment are essentially everything, positive or negative, that is available to living organisms. The environment in question is the artificial environment created by human modification of the natural setting (Gibson, 1979/2014). In other words, it refers to the historical, economic, and social aspects resulting from the dialectical confrontation between nature and human beings (Freire, 1997/2007). In light of the fact that, as Freire (1970/2005b, p. 88) explains, "world and human beings do not exist apart from each other, they exist in constant interaction." Since people reflexively (Kim, 2021) and experientially (Norman, 1999) determine affordances in the built environment based on their needs and dispositions, affordances may not be visible and recognisable (Norman, 1999). Affordances are objective in the sense that they exist at some point independently of perception. Still, they are also subjective in the sense that they vary within the action boundaries of individuals, making it challenging to define this term as subjective or objective clearly and singularly (Osiurak et al., 2017). In addition, affordances are formed as a result of the reciprocal relationship between the body and environment, as the human body is an integral part of the environment, and the body and space are mutually constitutive. In this vein, affordance has multiplicity because it varies according to the circumstances and individuals (Atmodiwirjo, 2014; Kim, 2021).

Affordance theory has been utilised frequently in industrial design, user interface design, psychology, and language learning. On the other hand, despite affordance being a fundamental concept in architecture and interior design/architecture, its role in those research areas has been limited (Kim, 2021; Maier et al., 2009; Murray & Fujishima, 2013). Consequently, we noticed that the literature has been relatively silent regarding the design studio concerning the notion of affordance (Rands & Gansemer-Topf, 2020). Moreover, given that the studio will continue to be one of the pillars of design education in the future (Goldschmidt et al., 2010), we urge that more initiatives and efforts are required to investigate this kind of educational environment based on primarily doing (Schön, 1987) and commoning (Hamilton, 2018) within the context of affordance theory.

3.Method

Structured as a participatory research method by Wang and Burris (1994; 1997) and based on Paulo Freire's critical pedagogy, feminist theory, social and cognitive constructivist approach, and documentary photography, photovoice is based on documenting everyday situations related to the research topic with photographs and then sharing and discussing the findings (Hergenrather et al., 2009; Wang & Burris, 1997; Wang et al., 2000; Wass et al., 2020). The photovoice method is used to enable participants to reflect on their strengths and weaknesses within the community or society, to promote critical and open dialogue about personal and social issues through group discussions, and to reach out to policymakers to inform them about issues of concern, and thus,

contribute to policy-making process (Biber & Brandenburg, 2020; Fleming et al., 2009; Wang & Burris, 1997; Wang, 1999; Wang et al., 2000). Wang and Burris first employed photovoice to visually document the health and working conditions of rural Chinese women who lacked access to cameras. With this approach, the argument that they do not have the ability and capacity to use the camera was challenged, and participants played a core role in their research (Wang & Burris, 1994; 1997; Wang, 1999). In this respect, the photovoice approach has been characterised as "a community-based participatory research methodology (Catalani & Minkler, 2010, p. 424; Woolford et al., 2012, p. 231)," "an ethnographic method of inquiry (Fleming et al., 2009, p. 17)," "an innovative participatory action research (Wang, 1999, p. 185)," and "a method for self-expression of such marginalised voices (Wainwright, Bingham, and Sicwebu, 2017, p. 409)." Consequently, this method serves a purpose beyond merely creating a visual data set on a specific topic. It allows for the embodiment of emotions and experiences while also establishing a systematic environment for defining, presenting, and developing research questions and findings.

We collected data during the 14-week spring semester between March and June 2023 by mainly taking photographs, partially taking field notes, and sketching through participant-observer roles at different periods. This multiplicity, through three different observation experiences and tendencies, was rather fruitful in visually documenting the connections between different students using the same studio and the studio affordances to comprehend the fieldwork from various perspectives and backgrounds. We first categorised the visual data collected into a shared digital file based on the first four questions of the photovoice technique. The questions were: "What do you see here? What is really happening here? How does this relate to our lives? Why does this situation, concern, or strength exist? (Wang, 1999, p. 188)", known by the acronym SHOWeD. However, we did not include the question, "What can we do about it?" in our analysis because it is beyond the scope of this study, and we do not aim to make any design recommendations as a result of this study. In light of this methodological framework, we first created initial themes and sub-themes by performing reflective writing individually on the photographs. Then, we synthesised the themes, sub-themes, and reflective writings – primarily descriptive and narrative, partly critical – through discussion sessions in a democratic manner, in other words, peer dialogues. Consequently, we have made some findings regarding the affordances of the learning space, as well as the responses generated by the students in reaction to the situations that they have encountered in the focused design studio. The themes, sub-themes, and reflections that resulted from a combination of the observation outputs of the three authors provided a holistic and deep perspective of student messages regarding the affordances of the educational environment we focused on. Hence, we defined a range of affordance-based message types indicating conflicts, collaborations, unexpected and practical solutions, and usages in Studio 203.

3.1. Setting and Community: Studio 203 as an "Undesigned Design Studio"

This dedicated section of this study digs into a detailed account of the undesigned design studio case that we applied, drawing upon the literature on design studios and affordance discussed in the previous part. In addition, the utilisation of photovoice as a research method. To understand what we mean by an undesigned design studio, it is essential to provide context by introducing our Faculty of Architecture, historically named and known Taşkışla, at ITU] that contains five design departments: Architecture, Interior Architecture, Urban and Regional Planning, Landscape Architecture, and Industrial Design. The interscale permeability of the faculty ranges from the city scale to the product scale and from the bachelor's degree to the PhD. Although this multidisciplinary permeability encourages an efficient educational environment, several issues with the physical learning environment result from this circumstance.

Due to the spatial and technical capacity of our

faculty and the departments' high quotas, multiple courses need to be conducted simultaneously within the same studio, or another class uses the same physical space immediately afterwards. These usage scenarios lead to constant changes and arrangements throughout the day based on the specific requirements of those students. Nonetheless, this characteristic, catalysing communication among students from various disciplines, requires unexpected and hidden collaborations and interactions but partly negative correlations. Furthermore, the absence of individualised spaces provided by the university formally in the studio results in a nomadic student situation or triggers the design students to create their own area using direct and indirect messages.

Within the scope of this study, Studio 203, which we determined as a field for this research due to its dynamic function, serves as an exemplary case and space in which the formation of the various message types discussed can be observed, documented, analysed and finally, co-interpreted. This studio undergoes constant changes and adaptations throughout the day, allowing for the investigation of how message types evolve and differentiate based on specific needs. At this point, we defined the design studio as "undesigned" to emphasise its confused and disordered structure, which was not planned according to users' cognitive, social, and physical needs. From another perspective, these "undersigned" and "non-customisable" circumstances in the studio where design education is provided to students make the realm of the study compelling. Thus, these circumstances trigger the production and diversity of message types, so the undesigned design studio serves as the starting point for all messages. As a summary of all the information presented, the parameters that allow us to define Studio 203 as an "undesigned design studio" can be summarised as follows:

- Insufficient classroom capacity and large student population: The limited capacity of the classroom and large student groups result in changes in the spatial use and organisation of the studio to accommodate different activities and applications such as body performance, jury sessions, shared discussions, individual studies, and group crits.
- Lack of individual storage and private spaces: The absence of designated storage and private spaces within the studio prevents students from producing and personalising their own space. Under such circumstances, the students attempt to arrange or create their own space with unexpected approaches by using intangible and implicit borders.
- The lack of control over the natural light source in Studio 203: Due to the lack of curtains or means to regulate the light, students tend to position themselves in the studio based on the available light, which is further influenced by factors such as temperature, the presence of direct sunlight, or shade. In fact, there could be a discernible temperature difference between the two extremities of the studio, which is a narrow and long space and resembles a corridor.
- Acoustic problems: The design of Studio 203 (70.6m x 5.4m), with its high ceiling (7.3m) and the presence of numerous students and lecturers, poses challenges for audio communication within the studio. Due to the studio's lack of partitions, walls, and acoustic control panels, the voices of the studio groups attempting to conduct their course in 203 simultaneously interfere with one another, resulting in cacophony (Figure 3).
- Access to electricity: In studios where computer-based work is integral, the arrangement of power sockets along the horizontal walls encourages students to sit close to each other and in close proximity to the walls. The absence of a charging system for electronic devices such as laptops, tablets, and mobile phones, and space in which the students work with them compels

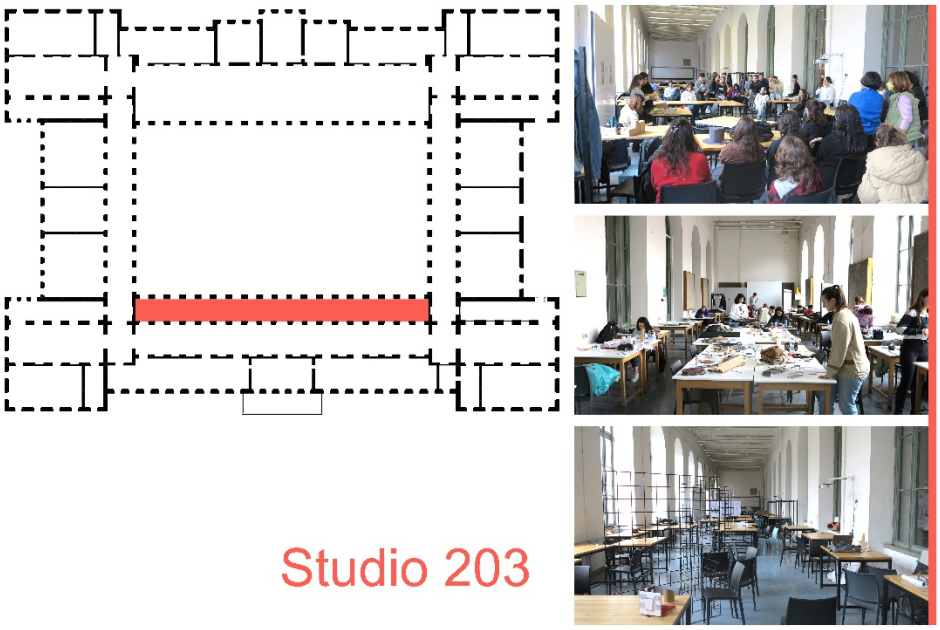

Figure 3: *Studio 203*

students to seek alternative solutions.

- Presence of cats: Unlike many architectural faculties, Taşkışla is a dwelling for an invaluable user group: cats. Some of these cats reside in and around the studios, adding funny, witty, and cheerful usage scenarios and relationships to the studio environment, as well as occasionally using certain feline instincts to differentiate in-studio usage.

4. Findings: Types of Messages in the Undesigned Design Studio

Considering the impact of the physical characteristics of the academic and educational environment on students' attitudes, behaviours, and learning, it is inevitable that the spatial possibilities and constraints within this context give rise to diverse social and cognitive relationships. In this regard, we have observed that the parameters we have listed contribute to a decrease in studio belonging, as students are unable to create their personal working spaces. As a consequence of this lack of belonging, we have identified the various forms of messaging that students typically engage in to protect their studio work or personalise their studio environment. As such, we have developed four main themes through our visual data analysis:

- Direct messages —which are clear and precise written and visual notes;
- Indirect messages —which students create by utilising the potential of the space to produce in response to their needs;
- Transcendent messages —which can be defined as a form of creative and artistic self-expression;
- No message but action —the combination of action and reflection.

Through these four themes, the undesigned design studio triggers a number of spatial conditions through which students express their ideas and necessities while providing different dimensions of communication and functioning as a basis of meaningful discourse and creative, implicit, and unwritten collaborations between classmates and even other classes without face-to-face interactions.

4.1. Direct Message: "Please Don't Touch"

> *Student: Someone moved my model carelessly to the back of the studio and placed their own model in my model's*

place. I then placed their model at the back of the classroom.

The need for different studio groups to use the same space at different times throughout the academic year and the lack of personal space and products in the faculty for the storage and private space needs of students force them to develop practical, rational, and implicit solutions. In addition, students frequently leave their models, posters, and materials in the studio, which is primarily due to the lack of personal storage space in their faculties and the difficulty of transporting them due to their large size and crowded public transportation. A number of students attempt to safeguard their projects by attaching written and visual notes on them to warn and inform other students and cleaning staff who work in the studio at different periods. The messages are placed on various materials such as cardboard, corrugated cardboard, foam board, styrofoam, and drawing paper, which they will use in/for their next class and next design stage. It attempts to keep it from being seen, taken, or damaged by others by placing it in inconspicuous placements away from typical usage of the classroom. As a result, the most common method they have developed for keeping their work secure in the studio is the use of written and visual messages. As researchers and teaching assistants working in the same studio at different times, we have noticed that "Please don't touch" is the most frequently communicated phrase (Figure 4).

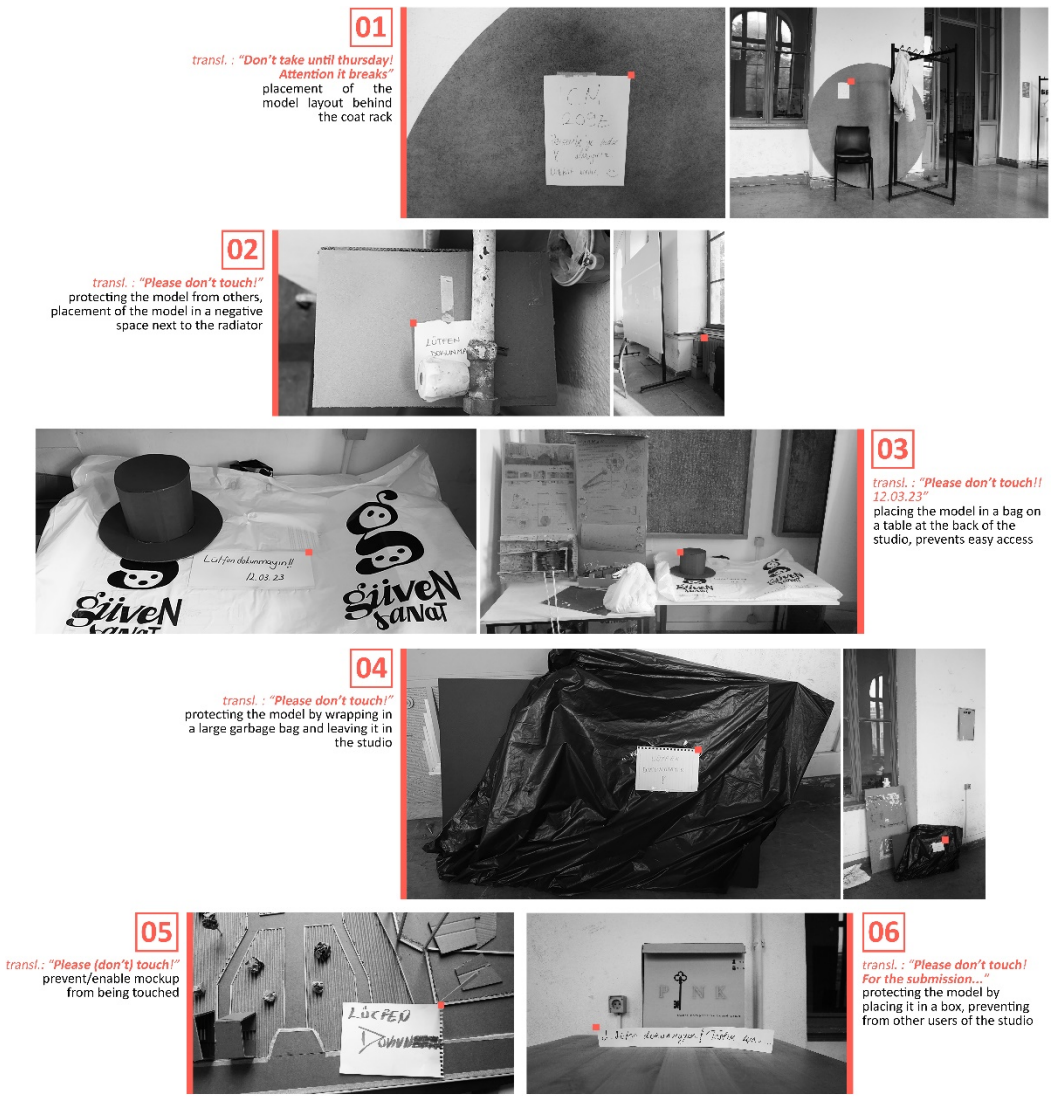

Figure 4: *Direct messages*

As Vygotsky (2012) argues about the nature of writing, the notes written by the students to convey to other stakeholders using the studio have a monologue structure. They are intended to warn and convey messages to them to influence their actions. Written language, which is used to document topics that are relatively foreign and distant from everyday life (Dewey, 2004), is the graphical embodiment of sounds, concepts, thoughts, ideas, and images – verbal in nature (Emig, 2020; McNamara & Allen, 2017). In addition, it should be as straightforward as possible in order to convey the message precisely (Vygotsky, 2012). Parallel to these perspectives, the students' direct messages in the design studio are succinct and striking.

4.2. Indirect Message: Storage within Intangible Borders

These types of implicitly meaningful in-class messages emerge to meet the students' needs in accordance with the study and life opportunities provided by the class. In contrast to direct messages, indirect messages lack written content and direct statements. Even if the meaning of the messages is clear to someone familiar with the studio, the messages may be meaningless or unnoticeable to an outsider. Indirect expression refers to the inferences and associations of thoughts in the mind. In other words, facts, objects, and relationships are transformed into mental representations based on the receivers' prior knowledge and background (Kuloğlu & Asasoğlu, 2010). In this context, we discovered that most of the students' indirect messages concerned the inviolability of the storage spaces they had designated. Since Studio 203 does not provide students with individualised study or storage spaces, students place their products and materials in unorthodox spaces. In this vein, indirect messages in Studio 203 are said to be based on "placement." At this point, it is possible to classify the students' indirect messages into three distinct placement spaces:

- Placing their works and materials under and mainly on the top part of the coat rack in the studio;
- Placing them on a higher surface than the general areas of use;
- Utilising the determined space, such as between the two walls and between the radiator and the wall, using them as a compartment for storage (Figure 5).

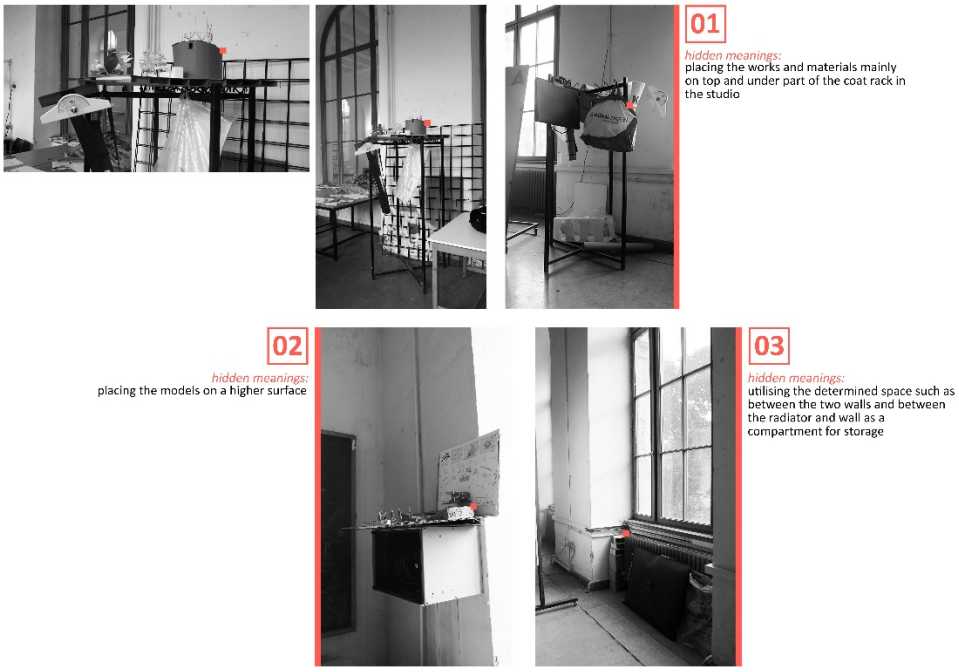

Figure 5: *Indirect messages*

Design students attempt to use and create studio spaces with perceptible but intangible boundaries for their needs, which are associated with personal working and storage spaces. Locating their materials and models in the mentioned spaces, making them untouchable, and these unwritten rules and storage usages/practices, which are implemented and accepted by the students, indicate that the model or material left behind is essential for future classes or juries and that the students did so intentionally. We noticed that the messages and emerging unwritten rules for protecting the students' work were generated non-verbally and informally by the students. This observation was based on the spaces' potential, the studio's complex physical conditions, and the learners' common respect and observance of these unwritten rules.

4.3. Transcendent Message: Self-expressions

We observed that the generation primarily comprised of learners aged 18 to 23, who tend to make the studio relatively more colourful and vivid. They view the design studio as an appropriate setting for their reflections and utilise it for this purpose, albeit not intensively. The notion of self-expression fits to frame the students' attitudes related to creativity and self-reflection in Studio 203. Self-expression, which can be defined as creative, artistic, and humorous production in our design studio, can be interpreted as an outcome of the student's desire to convey their discourse in the studio. The colourful expressions drawn and written on the studio wall could be considered an extracurricular form of expression and a subgenre of graffiti. In addition, the studio walls and several classroom objects have been manipulated and coloured, which may attain message quality and thus be converted into both implicit and explicit messages. However, they differ from direct and indirect messages in some sense due to their uniqueness and artistic quality because, beyond the transmission of discourse to stakeholders, the transcendent messages possess a unique and independent personality and embody the essence of the students who create the visual notes (Figure 6).

Learning and self-expression through artistic and creative acts (Dewey, 1980), which prioritise perceived qualities over expressed symbols (Van Den Akker, 2014), can create a new channel of communication by allowing students to think beyond the limitations of verbal language since, in Dewey's (1980, p. 118) words, "works of art, like words, are literally pregnant with meaning." Furthermore, Van Den Akker (2014, p. 756) associates the painting process with "existential-phenomenological experience in meditative

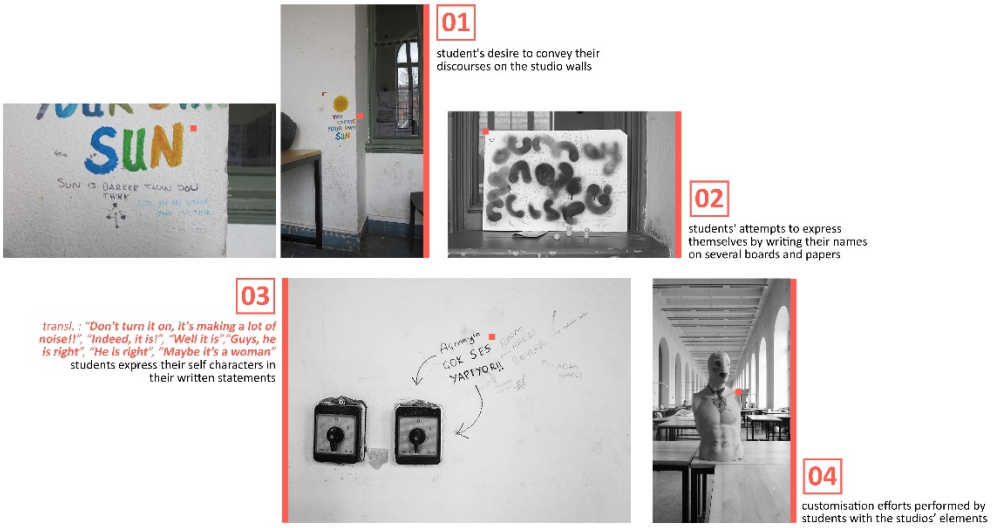

Figure 6: *Transcendent message: Self-expressions*

practice." Similarly, Pithouse (2011, p. 46) presents a radical discourse on the relationship between creative and artistic actions and the practitioner by stating, "making oneself visible through drawing." As a result, such self-reflective actions can strengthen students' communication skills as well as their social, political, and emotional perspectives (Van Den Akker, 2014), which are crucial for personal transformation (Mezirow, 1997). In this instance, we can argue that the transcendent messages that we have proposed serve as a mediator, i.e., as a means for practitioner students first to express themselves and then reach the receivers.

4.4. No Message but Action: Practical Reactions and Cats

This theme focuses on the physical capabilities and inadequacies of the studio, the student's immediate, practical, rational, and sometimes humorous solutions to the design space, and the role of cats in this ecosystem. It thus summarises the practical solutions and the role of cats, invaluable members, in the creation of affordances in Studio 203.

As in the other three headings, the faculty's limited space and technical constraints assume a crucial role in constructing the sub-theme: practical reaction. It emphasises action instead of creating a direct and indirect message to warn or inform other studio users. In this case, students behave proactively and develop inventive and logical solutions to their needs and problems, resulting in amusing situations. Examples include the use of a roll of cardboard as an angle adjuster to set the angle of the projection used during the presentations and the use of a chair as a solution to the incompatibility of electrical wiring and furniture positions in the studio. In addition, due to the lack of white backgrounds for taking photographs in the studio, students' efforts to create a temporary background are some of the solutions produced in response to the incompatibilities that arise in the scope of the design studio affordance and the intersection of humans, space, and products (Figure 7).

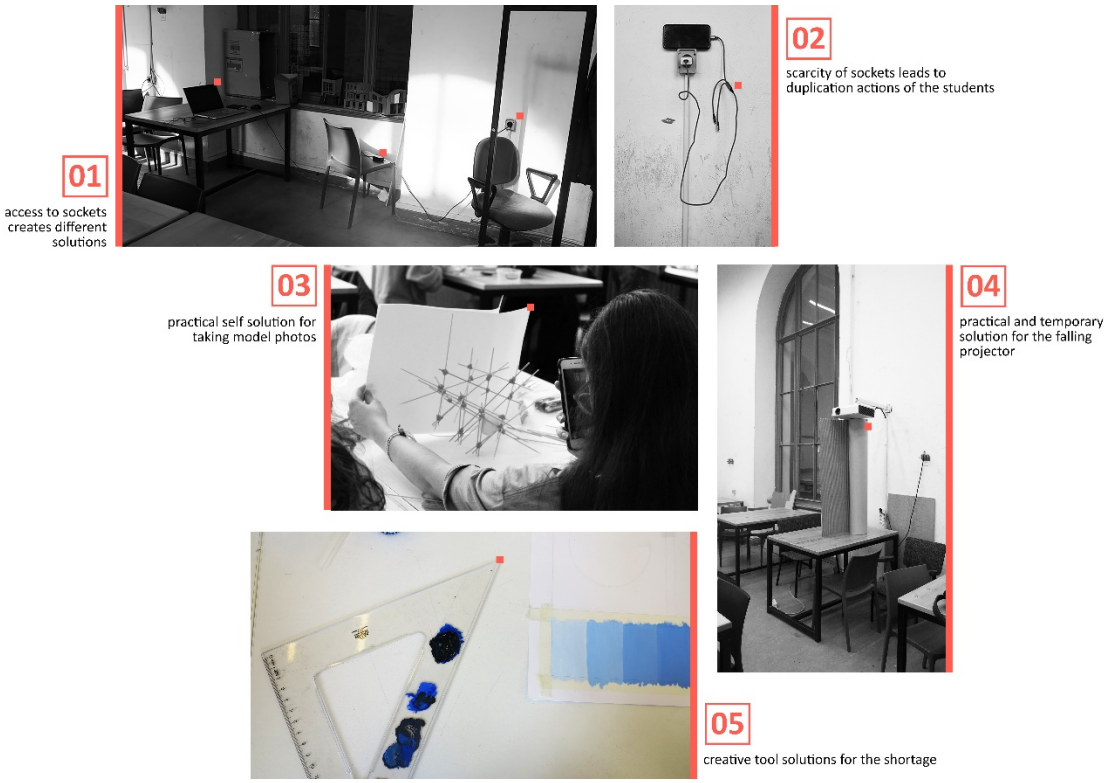

Figure 7: *Practical reactions*

Praxis, which is unique to humanity and consists of reflection and action, is a creative phenomenon that transforms people and their environment (Freire, 1970/2005b) because "men, unlike animals, are not only in the world but with the world (Freire, 1974/2005a, p. 3)." Humanity cannot, therefore, exist in a passive attitude, "but in word, in work, in action-reflection (Freire, 1970/2005b, p. 88)." On the basis of this assumption, all of the students' actions in the design studio can be interpreted as a reflection of human motivations to alter and transform the environment.

Another issue under this central theme is the relationship between the students and the dozens of cats who reside in our faculty, roaming the studios at will, sleeping and playing on or within students' models. In our educational milieu, cats are untouchable, cannot be judged or criticised for their actions, and have almost no concept of boundaries, even if they harm students' models and posters. Students have been observed leaving their studies or lectures to interact and play with the cats in our studio. From the smiles on the students' faces, we can assume that their interaction with the cats reduces their anxiety and stress levels. Consequently, cats become one of the critical parts of studio life and provide unexpected scenarios that enliven the learning environment. Regarding cats and spatial affordance, they use the models and materials to scratch/trim their nails and thus damage. At this point, there is not much that students can do other than put their models and materials out of the reach of cats. Therefore, the effect of cats cannot be ignored, especially in the formation of indirect messages (Figure 8).

5. Conclusion and Discussion

Within the scope of this study, carried out at the intersection of the design studio and the concept of affordance, we have reached two main conclusions based on the students' approaches and the studio's functioning. First, we found that affordances in the design studio make students active in producing and communicating messages. The fact that design education takes place in an undesigned studio

Figure 8: *Collage of the cats' manipulations*

environment, even against the primary function of the studio, makes students active makers and problem solvers against studio affordance. The conclusion we have reached based on the studio's functioning is related to the fact that the messages we have structured as direct, indirect, transcendent, and no message but action are developed against the studio's affordances or emerge as a result of the triggering of affordances. These implicitly or explicitly constructed messages provide spatial information about the functioning of the studio, but more importantly, the messages provide precise data for us to understand how the tangible and intangible functioning of the studio is perceived, interpreted and transformed by the students. We argue that through the uncovered messages, students construct a message network, both explicit and implicit, and that this network is a communicative and interactive part of the hidden curriculum.

Regarding the gains provided by the photovoice method, due to the scope of the research, the innovative application of the method and the roles we assumed, we, as researchers, experienced the affordances of the studio as much as the students did. In addition, our observations in the design studio through our written and predominantly visual data collection processes offered invaluable insights into understanding, internalising and communicating students' responses and solutions to studio affordances. In this way, we were able to access detailed and instant visual data by empathising with the students as stakeholders and users of the studio because, in the words of Dewey (1933, p. 252), "observation demands the mind to be alert, on the qui vive, searching and probing." Therefore, we agree with Wang et al. (2000) that this method can provide practitioners with a number of possible acquisitions, such as becoming aware of the environment, observing with curiosity, and imagining the world from someone else's point of view. As experienced researchers and teaching assistants, the participant-observer role and the photovoice method have contributed to our pedagogical perspective as trainee teachers by heightening our awareness and sensitivity to the educational environment we have been immersed in for years.

Regarding future research, this study was conducted within specific spatial and temporal boundaries. Hence, the findings on studio affordances could be diversified, developed, and expanded with additional field studies conducted in design studios in different countries, with students of various profiles and disciplines and with the cultural parameter's influence. Moreover, through the active participation of the students in both the data collection and evaluation phases, different details and relationships regarding the studio affordances and students' messages indicating their reactions could be explored.

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Damage Degrees of Historical Buildings After the Conflict in Diyarbakır Sur District

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Abstract: Diyarbakır, its significant historical heritage, became an important city in terms of cultural history. However, in 2015, the central area of this cultural heritage, the Sur district, suffered destruction. Although restoration efforts are ongoing, there remains a debate on the extent to which the damage has been mitigated. This area, home to religious, civil, and social structures, is designated as an urban conservation site. Preserving this area is crucial for safeguarding architectural diversity and the traces of various civilizations. Over time, the cultural heritage in the region has been affected by various factors until 2015 when clashes exacerbated the damage, resulting in substantial losses. Prior to 2015, an inventory survey was conducted to identify the historical structures in the area, which were damaged or lost during the conflicts. Based on damage assessments conducted by the Ministry of Environment and Urban Planning in 2019, the buildings were classified as severely damaged, moderately damaged, slightly damaged, undamaged, or lost. According to the survey, out of the 479 buildings examined, restoration was carried out on 204, while 9 were severely damaged, 5 were moderately damaged, 4 were slightly damaged, 254 were undamaged, and 3 were lost. The data obtained from the study indicates that detailed efforts have been made to address the destruction in the region. Restoration activities have positively contributed to the preservation of documentary evidence. However, the best option for preserving similar areas is to cease terrorist activities in Turkey and around the world to maintain the originality of humanity's common heritage.

Keywords: Diyarbakır, Sur district, Urban Conservation Area, Historical Environment, Damage Assessment.

1.Introduction

Anatolia, hosting many civilizations throughout history and being situated on numerous trade routes, has developed due to its rich resources and various other reasons. Therefore, Anatolia has hosted many civilizations throughout history, bearing the traces of different cultures and possessing a rich cultural heritage (Gülen, 2023 pp. 43).

One of the cities that has developed throughout history is Diyarbakır. Diyarbakır has been referred to by various names throughout its historical process. The city, known by names such as Amidi, Amedi, Amid, O'mid, Emit, Amide, Diyar-ı Bekir, was officially named Diyarbakır by the decision of the vekil council (Parla, 2005 pp. 59).

Due to its strategic location and fertile lands, Diyarbakır has been an important city

throughout history (Kejanlı et al., 2011: 97). Being situated on the banks of the Tigris River and on trade routes has kept the city economically and culturally vibrant. Therefore, rapid population growth has occurred in the city. The city has evolved from being a small fortress town to its present state. In this sense, Diyarbakır, like all other cities in Anatolia, has a high cultural diversity, especially with its historical structures, particularly the historic houses (Dinçer, Kartal, 2022 pp. 57).

The city's known history dates back to the dominance of the Subarians from 3000-1800 BC, during which the city's first fortified area was built. After the Subarians, it came under the rule of the Hittites, Mittanis, Arameans, Assyrians, Urartians, Scythians, Medes and Persians, Greeks, Seleucids, Parthians, and the reign of Great Tigran. Between 30 BC and AD 330, the city remained under Roman rule. Diyarbakır gained significance as a large and important city during the Roman period. After the Romans, the city came under Byzantine rule and later under Ottoman rule. Today, it is within the borders of the Republic of Turkey (Kejanlı et al., 2011 pp. 97).

The first settlement of the city was located on a rugged terrain named Fis Rock, approximately 625 meters above sea level and about 100 meters above the bed of the Tigris River, in the eastern part of the Karacadağ plateau. This area, called Amida Höyük, is where the first settlement in Diyarbakır was located (Uzun & Çalın, 2019 pp. 443). Amida Höyük is situated in the northeastern part of Sur district, known as the inner castle area. It is believed that Amida Höyük was built by the Hurrians, located in the northern part of the inner castle (Yılmazçelik, 1999). Amida Höyük is located in the northeast section of the city walls, facing the Tigris River. Its highest point is 683 meters above sea level. Amida Höyük is also known by the names Virankale, Virantepe, or Top Tepe. Excavations and research conducted at Amida Höyük have unearthed artifacts dating from the prehistoric period to the New Age (Ökse, 2015: 61).

Over time, the insufficient space in the city located within the inner castle was expanded by the construction of walls surrounding the Inner Castle. The inner castle covers an area of approximately 71 acres, with internal dimensions of 1100 meters (Tuncer, 2019). With the arrival of Christianity, Diyarbakır served as a central base and garrison during the Roman period. Therefore, the Inner Castle was expanded (Arslan, 1999). Administration in the growing city has always been based in the Inner Castle (Ateş, 2018).

The Inner Castle area, expanded and enlarged periodically, is now referred to as the Sur district. The Sur district reached its current castle boundaries during the Roman period (Dalkılıç et al., 2011).

The walls have four main gates located on the east-west and north-south axes. Dağkapı in the north, Mardinkapı in the south, Yenikapı in the east, and Urfa Kapı in the west. These gates are actively used for entering and exiting the city (Güneli, 2001: 28). The castle city is divided by four main avenues: İzzet Paşa, İnönü, Melek Ahmet, and Gazi Streets (Tuncer, 1999).

The streets branching off from the main avenues are areas where the city's structure is clearly observed. The positioning of buildings and plot boundaries shapes the streets. Therefore, the streets in the Sur district narrow, widen, bend, and do not have a straight line (Tuncer, 1999). The Sur district encompasses many architectural elements that constitute the city's urban fabric. The city is a rich cultural heritage site with its walls, mosques, churches, chapels, hans (inns), hammams (bathhouses), fountains, houses, and mansions (Yılmaz et al., 2013).

The most influential architectural structures shaping the urban fabric of the Sur district are traditional houses. Traditional house architecture consists of spaces arranged around a courtyard. The utilization of the courtyard in homes as a scenic area is due to the shaping of the Sur district within the city walls, influenced by climatic conditions. The masses arranged around the courtyard aimed to protect from or maximize exposure to the sun in summer and winter conditions (Tuncer, 1999). The urban fabric evolving within the city walls of the

Figure 1: *On the left, General view of the Sur district (Gabriel, 1930), on the right, General view of the Sur district 2021.*

region is characterized by narrow streets, as depicted in Figure 1, reflecting a sense of privacy expressed in the structures (Oruç, 2017 pp. 385).

The Sur district, with its rich cultural heritage, has attracted attention throughout history and has been the subject of research as an urban conservation area. Until the 1920s, the city, which displayed its development and change entirely within the city walls, emerged with the modernization movements and the formation of new settlements outside the walls. For years, the residents living within the city walls did not turn to the newly planned city outside the walls due to the sense of security provided by the walls. Therefore, the idea of demolishing the walls arose in 1931 by the governor of that period. In 1932, some parts of the towers to the west of Dağkapı and the intervals between them, and the intervals between two towers to the right of Mardin Gate were demolished, connecting the inner and outer Sur districts with a wide avenue (Dalkılıç et al., 2011). Modernization movements have also caused damage to other historical structures in the Sur district.

In addition to modernization movements in the urban fabric of the Sur district, factors such as migration, industrialization, natural disasters, human factors, and conflict have also led to destruction. In short, changes have occurred in line with the changing needs of people within the city's natural process (Kartal, Dinçer, 2023 pp. 1113). The "Diyarbakır Fortress and Hevsel Gardens Cultural Landscape Area," which entered the UNESCO World Heritage List in 2015, provides integrity to the settlement area, where serious damages occurred in the architectural, sociocultural, historical fabric, and identity of the region due to clashes between the Turkish Armed Forces and security forces affiliated with the General Directorate of Security and members of the PKK, YDG-H, and YPS organizations between December 2, 2015, and March 10, 2016. The clashes took place in the Cevat Paşa, Fatih Paşa, Dabanoğlu, Hasırlı, Cemal Yılmaz, and Savaş neighborhoods of the Sur district (TMMOB, 2019).

Urban conservation areas, which are among the cultural assets that need to be protected, have been damaged over time due to various factors and have reached the present day with their destruction. The Historical Sur district of Diyarbakır is also among the cultural assets that need to be protected. However, due to the clashes in 2015, it is a region that has suffered considerable damage.

While there are different methods for classifying the degree of damage to buildings, according to a study conducted by the Ministry of Environment and Urbanization in 2019 in

Turkey, the damage status in structures is classified as heavily damaged, slightly damaged, moderately damaged, and undamaged structures. Heavily damaged buildings are those with damage caused by the load-bearing system and are not in usable condition, posing a danger. In moderately damaged buildings, there are cracks in the load-bearing system ranging from 1 cm to 5 cm. There is also a risk of collapse in such buildings. Slightly damaged buildings are those with hairline cracks and do not pose a danger. Undamaged buildings are those without any damage (ÇŞB, 2019).

The Sur district is an area with significant historical value, and many studies have been conducted on its structures (Özyalvaç, 2011 pp.345-373; Sami, 2017: 1531-1546), as well as on its different values and contributions such as tourism, socio-economy, ethnic heritage (Çatalbaş, 2011, 2012 pp. 248; Durak, 2014; Mungan and Günay, 2018). The Sur district, which is a culturally rich region with many studies conducted on its cultural heritage (Parla, 2005 pp. 57-84; Kejanlı, et al., 2011: 95-108; Sami, 2022: 585-601), is a subject of debate regarding the damage to its cultural heritage caused by conflicts and how much of this damage has been remedied. In the literature review conducted, no study was found that determined the degree of damage to and addressed the current situation of the structures affected by conflicts in this area. With this study, the extent of damage to the immovable cultural heritage in the Sur district and the current status of efforts to remedy the damage are addressed.

According to a study conducted by the Ministry of Environment and Urbanization in 2019, the damage status in structures is classified as heavily damaged, slightly damaged, moderately damaged, and undamaged structures. Heavily damaged buildings are those with damage caused by the load-bearing system and are not in usable condition, posing a danger. In moderately damaged buildings, there are cracks in the load-bearing system ranging from 1 cm to 5 cm. There is also a risk of collapse in such buildings. Slightly damaged buildings are those with hairline cracks and do not pose a danger. Undamaged buildings are those without any damage (ÇŞB, 2019).

2. Material and Method

Diyarbakır, where the study area is located, is situated in the central part of the Southeastern Anatolia Region in Turkey's Southeast region (Çorbacı et al., 2021 pp. 103). It is bordered by Siirt-Muş to the east, Mardin-Urfa to the south, Urfa-Adıyaman-Malatya to the west, and Elazığ and Bingöl provinces to the north of Diyarbakır (Yılmazçelik, 1999).

The study area, the Sur district, is located in the city center. The area, which is still actively used as a settlement, consists of 479 registered structures, forming the material of the study. These structures include 43 residential buildings, 6 baths, 18 mosques, 6 churches, 1 bank, 6 fountains, 1 madrasa, 3 markets, 2 schools, 2 tombs, 3 inns, and 428 residential buildings.

Various methods have been utilized in the study. Firstly, archival and literature research methods were employed. Through archival and literature research, the pre-2015 conditions of the Sur district were determined. Then, on-site inspections and documentation were conducted based on the registration map and the conservation-oriented zoning plan to assess the current situation. Based on the current situation, damage levels were classified using the damage assessment definitions made by the Ministry of Environment and Urbanization in 2019.

3. Findings

The damage levels of registered structures in the Sur district were examined based on the definitions of damage assessment by the Ministry of Environment and Urbanization, and the structures were photographed as a result of the inspections conducted. The obtained data can be seen in Table 1.

Table 1: *Current Status of Registered Structures in the Sur District*

Buildings	Buildings whose restoration has been completed or whose restoration work is ongoing	Heavily Damaged Structures	Medium Damaged Structures	Less Damaged Structures	Damaged Structures	Disappearing Structures
Type and Number of Buildings	188 Residences	9 Residences	4 Residences	4 Residences	225 Residences	3 Residences
	3 Churches		1 Church		1 Church	
	7 Mosques				11 Mosques	
	2 Turkish Baths				4 Turkish Baths	
	1 Fountain				4 Fountains	
	1 School				1 School	
	2 Bazaars				1 Bazaar	
					2 Tombs	
					2 Inns	
					1 Madrasa	
					1 Bank	
					1 Official Institution	
	Total: 204	Total: 9	Total: 5	Total: 4	Total: 254	Total:3

After the conflicts that occurred in the Sur district in 2015, historical structures in the area were damaged. Through on-site inspections and one-to-one photography, the damaged structures were identified and classified according to their damage levels. The structures classified according to their levels were named with parcel numbers and tabulated (Table 1). Based on the prepared table, the damaged structures were color-coded on the Sur district map according to their damage levels (Figure 2).

According to the created map, it can be observed that in the eastern part of the Sur district, there is a concentration of buildings that have been restored or are undergoing restoration, along with some lost structures. It has been determined that these lost structures have been removed from registration and converted into streets. The eastern region encompasses the neighborhoods where the conflicts occurred, and it is observed that most of the damage occurred in this area, hence restoration efforts are ongoing here.

Figure 2: *Examples of buildings that have been restored or are in the process of restoration*

Figure 3: *Severely damaged buildings*

With the restoration efforts, the number of damaged buildings predominantly located in this area has been significantly reduced. Similarly, in the southwest part of the region, there are restored buildings, while in other areas, intact and slightly damaged buildings are predominantly found.

Figure 4: *Buildings with minor and moderate damage*

As a result of the examination, out of the 479 structures in the Sur district, as indicated in Table 2, 9 are severely damaged, 5 are moderately damaged, 4 are slightly damaged, 254 are intact, 3 are lost, and 204 have been damaged in conflicts and are either undergoing restoration or have been restored. The damaged buildings have been classified according to their types. Out of the 9 severely damaged buildings, all are residential; out of the 5 moderately damaged buildings, 1 is a church and 4 are residential; out of the 4 slightly damaged buildings, all are residential; out of the 254 intact buildings, 225 are residential, 4 are baths, 11 are mosques, 2 are tombs, 4 are fountains, 1 is a church, 2 are inns, 1 is a market, 1 is a school, 1 is a madrasa, 1 is a bank, and 1 is an official institution; out of the 3 lost buildings, all are residential; out of the 204 buildings undergoing restoration or already restored, 188 are residential, 2 are baths, 7 are mosques, 3 are churches, 2 are markets, 1 is a school, 1 is a fountain, and 2 are baths.

Figure 5: *Examples of undamaged structures*

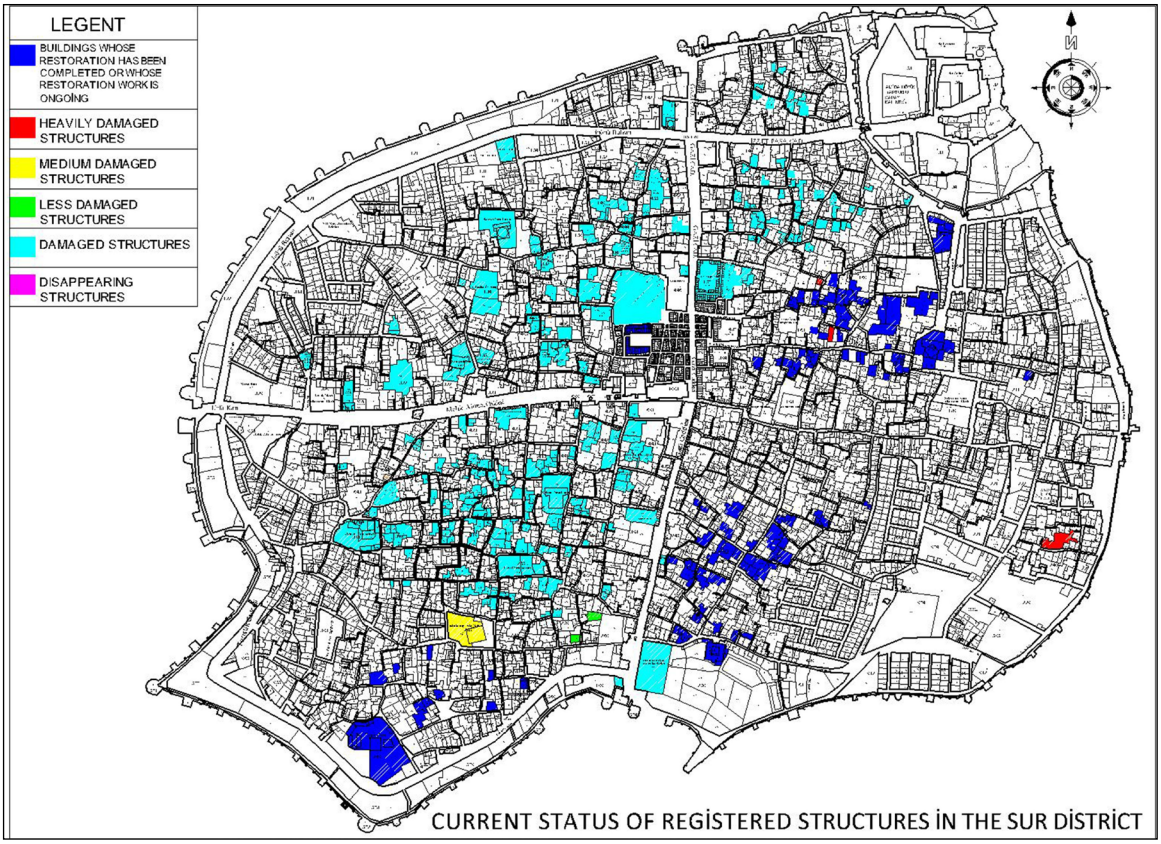

Figure 6: *Damage degrees of registered buildings in the Inner City*

Based on the data in Table 1, the current statuses of the structures on the zoning plan were processed to create a legend (Figure 6), and the areas in the Suriçi region that have been damaged were discussed.

4. Discussion and Conclusion

As a result of on-site inspections, it is observed that the indigenous population has left the region due to the intense conflicts and the extensive damage to the buildings, rendering

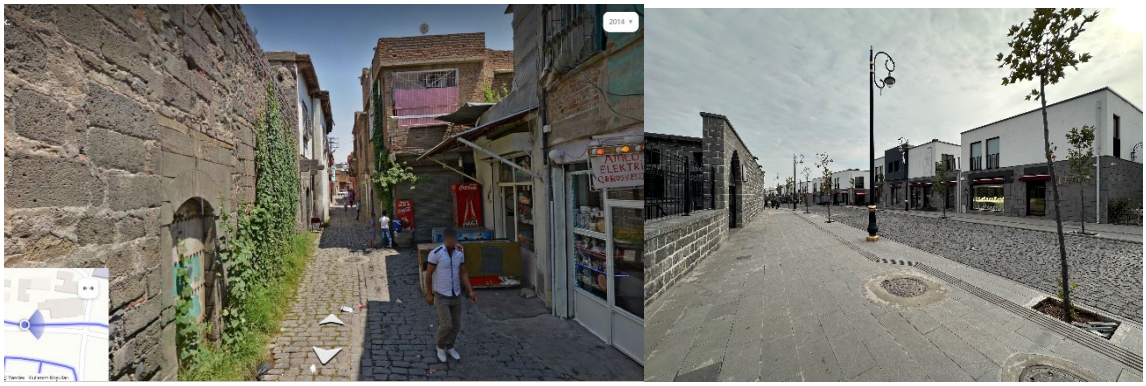

Figure 7: *The left photograph shows the Yenikapı Street Yandex Maps 2014 image, while the right photograph shows the Yenikapı Avenue 2022 image.*

them unusable. In this area, more damage is observed in the urban fabric compared to other areas. After the conflicts, significant damage has been inflicted and disappeared in terms of architectural, cultural, social, societal, and economic aspects.

Through on-site inspections, it has been determined that the street where three buildings were lost due to destruction has been transformed into a boulevard. It is observed that this boulevard is not compatible with the organic texture of the urban conservation area, indicating an application contrary to the urban fabric in this region. The wide boulevard constructed in contrast to the narrow alleyways of the Inner City disrupts the city's silhouette.

After the conflicts in the Inner City, restoration work on historical buildings has begun. It has been found that damaged structures are more concentrated in the eastern part of the Inner City, where conflicts were most intense. The findings indicate that restoration work in the area has reduced the number of damaged structures. While some structures have completed restoration, others are still undergoing the process. Additionally, restoration has not yet begun on some damaged, slightly damaged, and moderately damaged structures. It is imperative to commence restoration work on these structures as soon as possible. The significant progress in restoring damaged structures in the Inner City after the conflicts is considered a positive approach towards preserving the historical environment. However, the extent to which these restoration efforts maintain the original character of the structures requires further investigation.

Damage occurred to historical buildings in the Inner City after the conflicts. The damage has affected various types of structures in the area and has also led to losses in the urban fabric. Objective data on the destruction in the urban conservation area have been provided through meticulous on-site inspections and research.

Urban conservation areas are cultural assets that need protection. Historical buildings in these areas, as well as streets, squares, and other elements that contribute to the urban integrity and collective memory, should not be harmed. However, cultural heritage sites worldwide have occasionally suffered damage from conflicts for various reasons. There are several theories for preserving cultural heritage, which are often utilized in the preservation and restoration stages of damaged cultural heritage sites.

In addition to the restoration efforts initiated after the conflicts in the Inner City, some structures are still awaiting restoration, while others have not yet begun restoration work despite being damaged. It is imperative to commence restoration work on these structures awaiting restoration to eliminate the damage in the area as soon as possible.

Out of the damaged structures, 204 have either completed restoration or are currently undergoing restoration. However, restoration has not yet been initiated for 18 damaged structures. It has been identified that some streets have been widened or transformed into boulevards as part of the restoration efforts. Upon examination of the boulevard, it was found that three buildings were delisted and lost, and three buildings were reduced in size due to their alignment with the road. However, it is observed that these three reduced buildings have been restored to their original state. Widened or boulevard-transformed streets disrupt the urban fabric and emphasize the importance of adhering to the original characteristics of these streets.

In addition to the restoration efforts initiated after the conflicts in the Inner City, any new concrete buildings constructed adjacent to or in close proximity to historical buildings in the urban conservation area should not disrupt the city's fabric, overshadow historical structures, or undergo drastic changes in the urban memory. Preserving the organic form of the Inner City requires the conservation of its narrow alleyways as part of urban design projects to be passed down to future generations. Modern buildings and urban designs in areas where the urban fabric has been completely lost should not contradict the city's

fabric. When it comes to individual buildings, efforts should be made to complete the missing parts of historical buildings or those partially lost through comparative studies with regional architecture, old photographs, and data. Materials used in restoration work should be compatible with the existing materials in the building and should not disrupt the silhouette of the structures. Construction techniques should adhere to the original construction methods. Modern additions to historical buildings should not harm the structure or disrupt its original character.

In conclusion, although it is evident that extensive efforts have been made to rectify the damage to many historical buildings, it is the hope of not only architects but also all humanity that such acts of terrorism do not recur in the region, our country, and the world.

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Constructional Designs of Architecture Students – Were Building Subsystems Successfully Integrated During the Project Process?

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Abstract: Integration problems between building subsystems designed by different specialists may arise when not properly coordinated. Alongside their design duties, architects often have control/coordination responsibility to avoid these. Gaining experience in integrating building subsystems is an objective of the Construction Project course in the Istanbul Technical University Bachelor of Architecture Program. Final submissions of the author-led groups were evaluated to determine design deficiencies and integration problems observed and to discuss students' performance in subsystem integration. Using a classification framework generated for determining the types of subsystem integration, design deficiencies and integration problems based on literature, 20 student projects were reviewed in this respect. Drawings of each project for the architectural, structural, heating and plumbing systems were assessed within themselves and in pairs to find inconsistencies. Regarding the integration problems identified, opinions of a few professionals on their significance in causing rework were taken via a questionnaire to assist the discussions. Students' performance was assessed using both quantitative findings regarding the number and type of design deficiencies and integration problems identified and professionals' opinions. In total, 12 design deficiencies and 20 integration problems were identified. Among the deficiencies, the occurrence rate of errors was higher than that of the omissions (i.e. 61% and 39.2% respectively). Among the integration problems, the structural system was always a component of the subsystem pairs with a high occurrence rate of problems (i.e. >50%). Regarding different types of integration problems, omission was the least commonly observed problem followed by error, and soft and hard clashes respectively.

Keywords: Building fabric, Technical design, Systems integration, Architecture education, Design deficiency, Clash detection

1.Introduction

In building design, various actors take design responsibility for different subsystems of the building. Their design processes often continue separately and concurrently. This separation can lead to unintended interferences occurring between these subsystems that need to be solved at the construction site unless detected during design (Gross, 1994). These interferences, i.e. poor physical coordination and integration between different subsystems, are still an ongoing problem and may cause construction rework which in turn can cause cost increase and rescheduling.

Assaf et al. (2018), for instance, based on interviews with consultants, ranked the lack of cross-disciplinary coordination 3rd in significance in causing rework. Ye et al. (2015), based on semi-structured interviews with

experts, in addition to 'poor coordination of design team members' that was 6th in rank in causing rework, identified 'design error/omission' as another cause, which was 5th in rank. Asadi et al. (2023), based on surveys, similarly listed 'incomplete design, any omission in the design or construction process' and 'error in design, drawings, and specifications/error in construction' among factors with an effect on rework.

Research studies are being made to overcome these problems, especially in the information technology field concerning the physical coordination problem. Clash detection tools available for Building Information Modelling (BIM) applications provide opportunities to resolve that (e.g. (Merschbrock & Munkvold, 2015; Jafari, Sharyatpanahi, & Noorzai, 2021)). Yet, studies also show that even when BIM is adopted, there are still some barriers. Akponeware & Adamu (2017) stated based on a survey that working in isolation from each other was the most important cause of clashes. Clash detection tools are also not precise enough yet, and may report irrelevant clashes. Therefore, studies to improve their precision are being done, e.g. (Hu, Castro-Lacouturea, & Eastman, 2019).

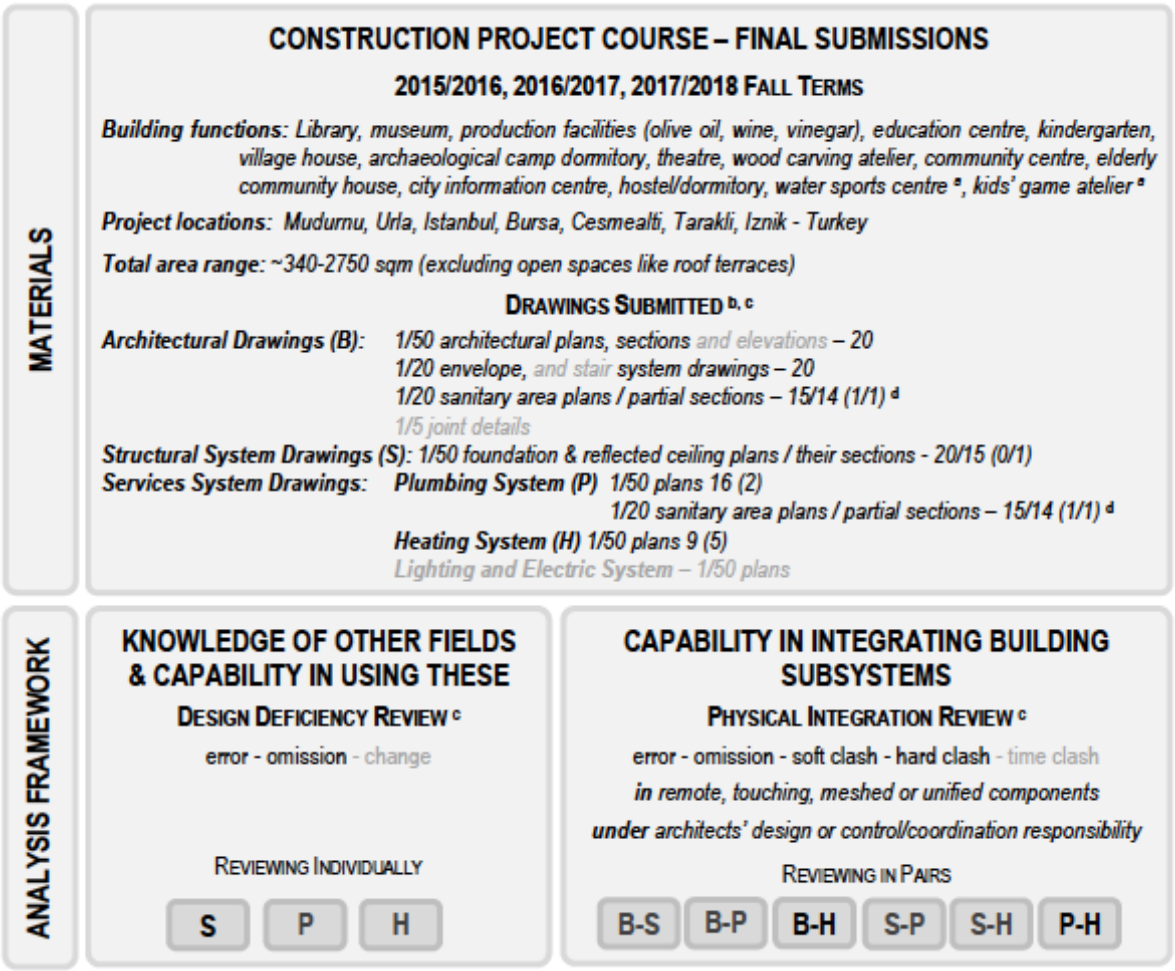
The curriculum of architecture education contains technical courses to equip the students with the necessary knowledge of the interacting fields, in varying proportions according to the different architecture schools. These courses and other courses in the curriculum also aim to provide an insight into an integrated project, where different subsystems are properly integrated both functionally and physically. There are also active efforts for a better integration of the knowledge of the interacting fields. Design/project-based learning is one of the strategies used for this purpose. Ünay and Özmen (2006), for instance, discussed their strategy of taking the architectural design studio into the centre to teach structural systems to the architecture students where structure instructors have participated in the design studios. Similarly, Uihlein (2013) explained the design-based methodology employed in the advanced structural planning course in architecture education to create a link with structural engineering. Integration of the architectural design course and the structural and technology courses through the assignments is another approach to this end. Bakar et al. (2023) assess the use of this approach during the term for integrating architectural design studios and various technology-related courses. Their findings indicate that the students found this approach effective for gaining an understanding of technical subjects, yet expressed a sense of lack of proper integration of those subjects into the design. Likewise, Metin (2023) presented the use of assignments and studio work for the integration of the building technology knowledge, but with an integration across terms by using the previous architectural design studio courses outputs and their step-by-step development through various technology courses. In these studies and others, some illustrative examples of student work or the students' views on achieving these objectives are usually presented. Nevertheless, given the ongoing problem of unintended interferences faced in the professional field, there is a need for a systematic review and analysis of student works to determine the students' performance in integrating different subsystems at least physically.

At Istanbul Technical University, in the Bachelor of Architecture Program (ITU-BArch), a fourth-year course named Construction Project, besides other objectives, aims to teach integrating architectural systems with remaining building subsystems designed by other specialists. This is carried out in a design-based learning environment, and students usually experience the full design process at a small-sized building. In view of the fact that eliminating the problems of unintended interference and design error is found important in the construction industry, especially in minimising construction rework, the outputs of this course given by the author were systematically evaluated in these respects, and the findings are presented here. Additionally, as a NAAB (National Architectural Accrediting Board – US) Internationally Certified program, graduates have to gain a certain understanding and/or ability regarding these systems (NAAB,

2019). Therefore, their ability to use the knowledge about these systems in their designs was also investigated.

2. Materials and method of the assessment

The objectives of the Construction Project course given each term by various academics are; (i) developing skills to create architectural solutions considering technical, legislative and aesthetic issues, and the skills to develop and integrate subsystems, (ii) learning building material selection, and (iii) gaining experience in technical design and preparation of design documents. Each term, each group's (ca. 6-12 students) study subject and work scope are determined individually by the leading academic. Here, all final submissions of the groups led by the author in three years are considered. The analysis was limited to three years as its findings may affect the author's way of tutoring in the proceeding terms. 20 projects were evaluated in total, and information about those is given in Figure 1.



a: Projects designed by student pairs. **b:** The numbers following the drawing explanations indicate the number of projects containing those drawings, and if given, the numbers in parentheses indicate the number of projects, where only some of the associated drawings were present. **c:** The items given grey in colour were not assessed here. **d:** These drawings were considered under the plumbing system in the design deficiency review, and under the architectural system in the physical integration review.

Figure 1: *General information on the projects and the analysis framework.*

In these groups, students individually designed and detailed a small/medium-scale building, except for the two projects worked on in pairs. Building functions were decided by the students considering the necessities of project locations. During the term, following building programme preparation, they conceptually designed the building and its structural system accordingly. The building element assemblies were then decided, and followed by the conceptual design of services systems. Finally, they worked on the joint details of building elements. The final project items submitted are listed in Figure 1. All structural and services systems drawings could not be submitted sometimes due to time shortages. Thus, project counts with relevant drawings are also given in the figure.

The assessment of these 20 projects was carried out in four main stages, which are; (i) determining the analysis and classification framework based on literature, (ii) reviewing the projects considering the framework, (iii) getting professionals' _opinions on the integration problems identified via a questionnaire, and (iv) discussing the findings quantitatively and qualitatively. The structuring of the framework and the steps followed in the succeeding stages are detailed in the following subsections.

2.1. Determination of the analysis and classification framework

The objective of the project review was twofold; to understand (i) the knowledge of students in other fields and their capability in using these in their designs, and (i) their capability to integrate building subsystems (Figure 1). For both purposes, a building subsystem classification was needed, and benefiting from the building fabric and building element classifications given in (ISO, 2016; Rich & Dean, 2015), building subsystems were accepted to be (i) structural system, (ii) services systems, and (iii) building elements system covering walls, roof, floors, windows/doors, and stairways/ramps. The latter system is mainly under the architect's design responsibility and is therefore called 'architectural system' in the text sometimes. The former systems are designed by engineers with the direction, control and/or coordination of architects.

Concerning the first objective, the course prerequisites are the individual courses on structural and service systems, in addition to those on building elements. They practice using previously gained knowledge by conceptual design and drawing of structural and services systems for their projects. Therefore, their success in these drawings can be taken into account for assessing their knowledge and capabilities on these subjects, and the number of design deficiencies can be used as an indicator.

Design deficiencies, as defined by Lutz et al. (1990) are "the conflicts, omissions, or errors in the design documents". These are stated to have potential impacts on the building's quality and the construction phase such as the rework necessity. They additionally referred to 'disagreements between drawings, specifications' and 'interdisciplinary coordination errors' as two of the commonly seen deficiency types, where the latter is directly related to the second objective of this study; subsystem integration. Burati Jr. et al. (1992), in their study on quality deviations, stated 'error', 'omission' and 'change' as the types of rework causes, and benefiting from their classification and explanations, the design deficiency types to be searched in the projects were decided to be as follows as also given in Figure 1:

- error - an incorrect item, i.e. a mistake;
- omission - any part of a system that has been left out.

Concerning the second objective, different integration types are present, even at the 'hardware-level' as used by Bachman (2003). Examples of these are; performance integration concerning the delivery of shared function(s) (Bachman, 2003; Hartkopf, Loftness, & Mill, 1986), visual integration dealing with the aesthetical arrangement of exposed components mostly (Bachman, 2003; Rush & Stubbs, 1986), physical/geometrical integration considering the spatial relations and connections of

components (Bachman, 2003; Rush & Stubbs, 1986). Here, the physical/geometrical integration considering spatial relations and connections of these subsystems and their components was investigated. To analyse in what type of system interactions the problems were mostly observed, Rush and Stubbs' (1986) subtypes were adapted to define the systems' ordinary relation as follows by combining two of their subtypes:

- remote - systems are physically separate but still coordinated functionally;
- touching - one system rests on another, and/or attached by adhering or mechanical means;
- meshed - systems occupy the same space;
- unified - systems share one physical form.

Regarding physical/geometrical integration, 'clash detection' is the process of checking spatial relations of building subsystems and components i.e. physical interaction between them. It also covers control of time-related issues. In general, three different types of clashes are mentioned in the related literature as follows (Allen, Becerik, Pollalis, & Schwegler, 2005; Staub-French & Khanzode, 2007; Tommelein & Gholami, 2012; Wang, Wang, Shou, Chong, & Guo, 2016):

- soft/clearance clash - components are close to each other beyond the allowable limits or spatial conflict of components will be solved during construction as a common practice;
- hard clash - components that need to be remote or touching are unintentionally sharing the same space, fully or partially;
- time/schedule-clash - spatial problems related to constructability and operability of the facility or scheduling clashes of the workforce, tools, etc.

Here, to understand the students' success in integrating building subsystems, the soft and hard clash counts were used as indicators. As interdisciplinary coordination problems are also mentioned under design deficiencies, and since some problems may not lead to a clash depending on the design conditions, error and omission were also included in the integration problem types (Figure 1). Additionally, to investigate in which responsibility of the architect the integration problems are mostly observed (i.e. design versus coordination/control), this kind of grouping was also included in the analysis.

2.2. Review of the projects

In the analysis, initially, the structural, plumbing and heating systems drawings of each project were reviewed individually to determine, list, and group the design deficiencies (Figure 1). Regarding these;

- In structural system (S) drawings, the discrepancies between reflected ceiling/foundation plans and their partial sections (i.e. errors), and fully missing components for an appropriate load-bearing performance (i.e. omissions) were searched for. Components present on plans but missing in sections, or vice versa were considered drawing mistakes and called errors.
- Regarding plumbing system (P) drawings, only the omissions were searched for in 1/50 layout designs, as sections were not requested. In 1/20 drawings both design deficiencies were searched for when partial sections were available. While listing the problems, each different type of missing plumbing component was considered a separate problem to be more definite.
- In heating system (H) drawings, 1/50 general layout plans were checked, again only for the missing main system components (i.e. omissions) since schematic sections were not requested, and each missing component was defined as a separate problem, similarly.

In the second phase of the project review, architectural drawings (B), structural system drawings, and services systems drawings were comparatively reviewed in pairs to determine and list integration problems (Figure 1). In these reviews, the list of commonly observed problems prepared regarding the projects of the 2015/2016 fall term was used as a base (Edis, 2016). While listing an integration problem, the ordinary relation between the associated components, its type in terms of being an error,

omission or clash, and the architects' duty in this problem were also determined.

In both reviews, the existence of a problem in a project was counted, independent of how many times or at how many places it was observed at that project. The occurrence rate of each problem was then calculated considering the total number of projects with relevant drawings.

2.3. Getting the opinions of professionals

To get some insight into the perspective of the associated community in Turkey and provide a basis for discussing the importance of the observed integration problems, the opinions of a few practising architects, civil engineers, and architect academics were taken through a survey of voluntary participation, using the integration problems list prepared in the previous stage. In the questionnaire prepared for this purpose, the significance of these integration problems in causing construction rework was asked without giving any drawing examples from the final submissions of the students. A five-point Likert scale was used to define the significance of 20 problems listed, where one (1) indicated 'totally insignificant', three (3) indicated 'neither insignificant, nor significant', and five (5) indicated 'very significant'. The averages of the answers of seven respondents with different professional backgrounds (i.e. two academic and three practising architects, two practising civil engineers) were then used briefly in the discussions concerning the outputs of the integration problem review, i.e. the findings of the second phase of project review. The responding architects, all of whom graduated from ITU-BArch, had 21-23 years of experience, and the civil engineers' experiences were between 9 and 13 years.

2.4. Discussion of the findings

The findings of the design deficiency review were discussed briefly considering the associated NAAB student performance criteria (NAAB-SPC) and the number of deficiencies together. An overall assessment was also made to determine in which system's application the students were more successful, and whether the findings were similar to the cases regarding professional practice.

Regarding the findings of the integration problem review, initially, the type of integration problem, e.g. soft or hard clash, was discussed considering the interaction type between the components, construction phases and/or the availability of proposing a solution. The professionals' opinions were also considered to investigate and discuss whether there was a mismatch between the classification and the significance rate. Additionally, the relation between the component interaction type and integration problem type was examined to determine whether there were any definite patterns. An overall assessment was made finally to determine system pairs with most problems.

3. Findings of reviews and discussions

The review findings regarding two objectives are given and discussed below in two main subsections.

3.1. Design deficiency review

Errors and omissions were searched in the individual review of structural, heating and plumbing systems drawings as design deficiencies. Deficiencies found in this respect and their occurrence rates are given in Table 1, and explained and discussed in the following subsections together with some examples from the projects. In these examples, issues related to integration problems were noted too when relevant. In all drawings given, some items such as construction lines, codes, etc. were removed from the originals, when necessary to improve the problem visibility, and author-made cuts were shown with dotted lines.

3.1.1. Structural system drawings

Among the deficiencies, errors were remarkably more common than omissions, and among the errors, S_1 size/shape/position discrepancies had the highest occurrence rate, some of which were caused by considering a different component while aligning or drawing (Figure 2-A). Regarding missing components in partial sections, S_2 concerning those in elevation view (Figure 2-A) was considerably

more common than S_3 concerning those in section view (Figure 2-B), which might show that students focused more on items in section view, rather than the ones in elevation view. Regarding the omission of components necessary for proper loadbearing performance (S_4), the problem was identified to occur in four projects. In two of these projects, considering that a major change was made in the architectural design after the initial conceptual design of the structural system, the omission of necessary structural members was most likely because of not rechecking the structural design after that major change, rather than a lack of knowledge on the subject (Figure 2-C).

NAAB-SPC expects the ability to apply the appropriate structural system (NAAB, 2019), and among these design deficiencies, S_4 is an important indicator of students' knowledge and capabilities. It had the lowest occurrence rate together with S_3, and when thought together with the fact that half of these cases were presumably the result of forgotten rechecks after a major revision, it can be said that almost all students had the necessary understanding of structural behaviour and the ability to apply structural systems.

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Table 1: *Design deficiencies in drawings*

Code	Design deficiency observed (scale of drawing when necessary)	DT	CP_D	CP_T	OR (%)
S_1	Components having different sizes/shapes/positions in plans and partial sections, or in different structural plans	E	11	16	69
S_2	Components present on plans but missing in elevation view in partial sections (i.e. column, beam)	E	10	15	67
S_3	Missing structural planes partially/fully in the partial sections	E	3	15	20
S_4	Missing columns or beams necessary for proper load-bearing performance	O	4	20	20
P_1	Missing supply pipes and/or drains for some locations (excluding rainwater capture and use) (1/50)	O	4	18	22
P_2	Missing pipes to and/or from rainwater storage tank (1/50)	O	7	15	47
P_3	Missing some/all cleanout manholes and/or their connection to city sewage system (1/50)	O	9	17	53
P_4	Missing water/rainwater storage tank (1/50)	O	2	17	12
P_5	Missing horizontal supply pipes and/or drains (1/20 plans and/or sections)	E O	13 3	16	100
H_1	Missing chimney	O	6	10	60
H_2	Missing fuel supply/storage	O	10	10	100
H_3	Missing horizontal distribution pipes to radiators/vertical heating system pipes	O	2	10	20
DT: Deficiency type, **CP_D**: the number of projects with deficiency, **CP_T**: The total number of projects with relevant information, **OR** (Occurrence Rate): CP_D/CP_T in percent, **E**: Error, **O**: Omission					

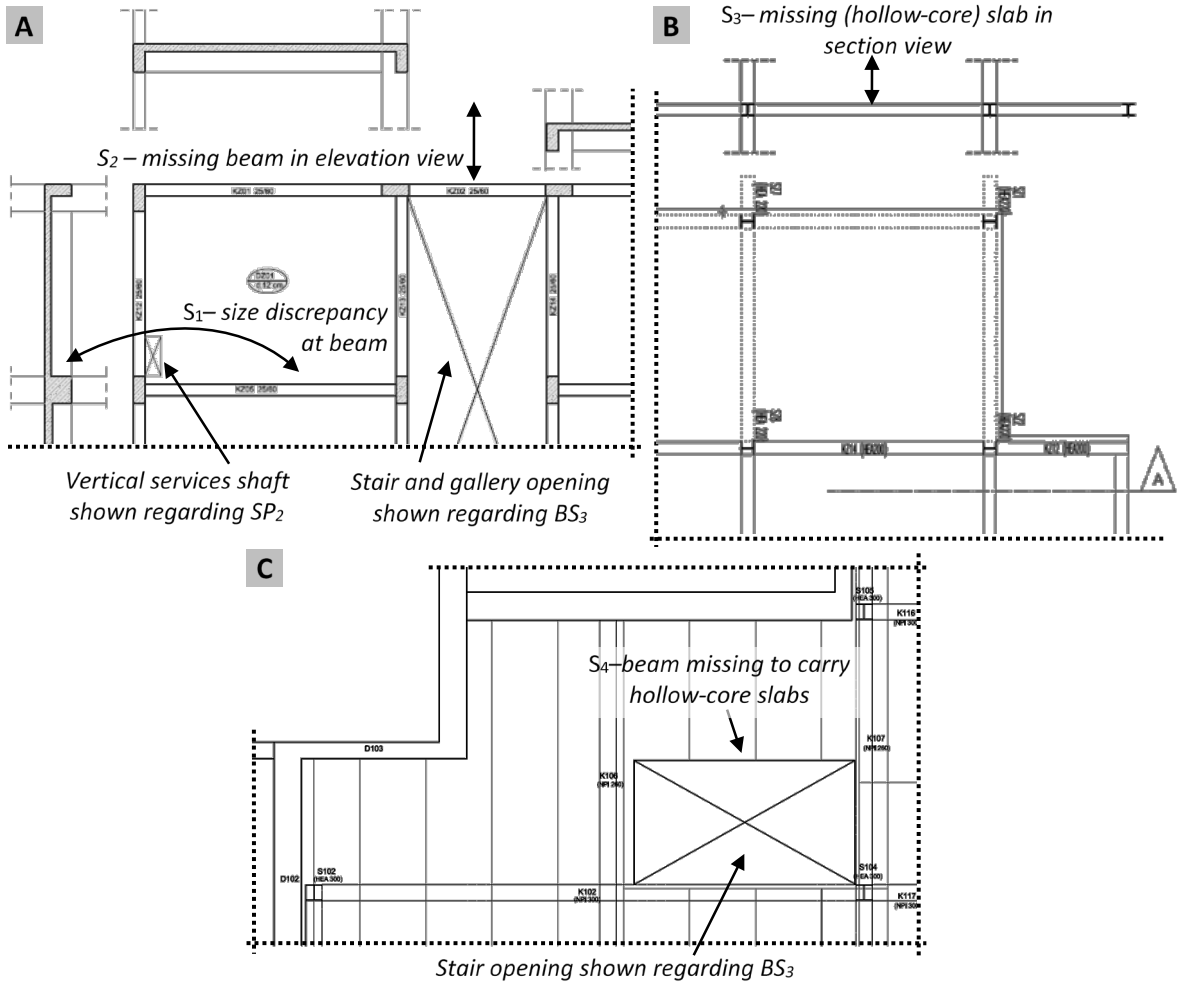

Figure 2: *Examples of structural system design deficiencies.*

3.1.2. Plumbing system drawings

Within the problems regarding 1/50 plans, omissions of manholes (P_3) and connections to/from rainwater tank (P_2) had the greatest occurrence rate respectively, with a considerable difference from others. About P_3 (Figure 3-A), in five projects, at least one manhole was drawn which shows that students knew its necessity, but were not precise about where to put or how many to use. About P_2, the rainwater tank-roof connection was omitted mostly (5/7) without any apparent reason. As a whole, missing supply pipes and drains in 1/20 sanitary area drawings (P_5) had the highest occurrence rate with 100%. However, in most of the projects with the P_5 problem, pipes and drains were properly shown in their 1/50 plans (Figures 3-B and C). Therefore, regarding deficiency type classification, P_5 observed in projects with proper 1/50 plans were called errors, while the ones without relevant 1/50 plans were called omissions.

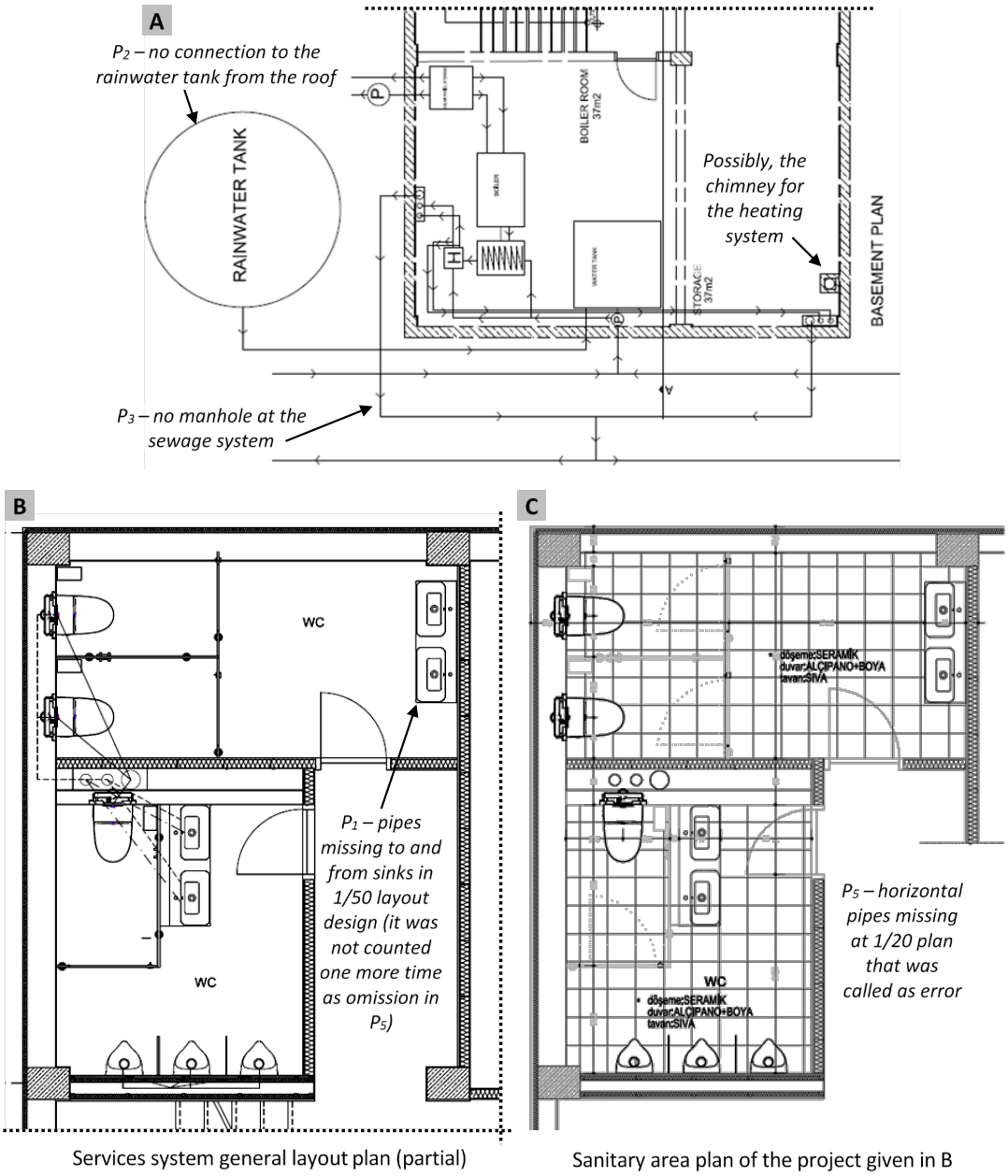

Figure 3: *Examples of some plumbing system design deficiencies*

NAAB-SPC expects an understanding of the basic principles and appropriate application of building services systems (NAAB, 2019). When errors regarding P_5 are excluded, most students can generally be said to have the necessary understanding of the fundamental application principles of the plumbing system and can associate them with their designs, as the entirely missing component counts were too small.

3.1.3. Heating system drawings

As the most common design deficiency, in none of the projects with relevant plans, the fuel supply connection to the heating unit from the city supply system or fuel storage area necessary in one project was provided (H_2).

Similarly, in most projects with relevant plans, there was no chimney for the heating unit (H_1). These might show that students usually focused on the internal connections of the system, rather than their external connections when considered together with the small occurrence rate of missing pipes reaching inhabited floors.

In summary, considering that inhabited floor plans did not contain deficiencies, it can be said that the necessary understanding had been gained about most principles and components of the heating system. However, in the future, students' attention needs to be directed more to external connections.

3.1.4. Comparative discussion of design deficiency review

For each deficiency type in each system, cumulative sums of the project counts with deficiency and the total number of projects with relevant information (i.e. ΣCP_D and ΣCP_T respectively) were examined for a comparative analysis (Table 2). When all systems were considered together, the occurrence rate of error was considerably higher than that of omission. Love and Li (2000), in their project analyses, found similarly that the number of design errors was considerably more, which resulted in higher rework costs. Likewise, in the study of Burati Jr. et al. (1992), the design error rates were considerably higher than design omission rates. Considering all, it can be said that a pattern similar to that of real-life projects was present in the students' projects, where errors were more common than omissions. From the educational perspective, the smaller rate of omissions can be considered a good sign of gaining the necessary knowledge on the principles and applications of these systems.

When the total occurrence rate of both deficiencies was analysed for each system, the students were observed to be more successful in structural system design with the lowest occurrence rate of 40.9%. However, when P_5 and H_2 present in all relevant projects were excluded from the analysis, the deficiency-free project count was higher for plumbing and heating systems (i.e. five and four projects respectively), while there was only one deficiency-free project for the structural system. This also shows that the number of design deficiencies can be reduced in the future by stressing more on issues regarding P_5 and H_2.

3.2. Integration problem review

Error, omission, and soft and hard clashes were searched in the drawings as integration problems. Problems observed in this respect while reviewing the building subsystem drawings in pairs are given in Table 3. Their occurrence rate and professionals' opinions (PV) on their significance in causing rework are also given in the same table. The simple averages of the responses are presented for this purpose where 3 was used in the questionnaire to indicate 'neither insignificant, nor significant', and 5 to indicate 'very significant'.

Table 2: *Total numbers of design deficiencies.*

	Structural System			Plumbing System			Heating System			All Systems		
	ΣCP_D	ΣCP_T	OR (%)	ΣCP_D	ΣCP_T	OR (%)	ΣCP_D	ΣCP_T	OR (%)	ΣCP_D	ΣCP_T	OR(%)
Errors	23	46	50.0	13	13	100	0	0	0	36	59	61.0
Omissions	4	20	20.0	25	70	35.7	18	30	60.0	47	120	39.2
Errors + Omissions	27	66	40.9	38	83	45.7	18	30	60.0	83	179	46.4

ΣCP_D: Cumulative sum of CP_D ΣCP_T: Cumulative sum of CP_T OR (Occurrence Rate): $\Sigma CP_D/\Sigma CP_T$ in per cent

Table 3: *Integration problems in drawings.*

Code	Integration problem observed*	AR	IT*	IPT*	PV	CP_I	CP_T	OR (%)
BS_1	Structural components with different sizes/positions in structural and architectural drawings	DR	R (6) T (7)	E (6) E (4) C_H (3)	4.71	13	19	68
BS_2	Missing (10) or additional (3) beams in architectural sections	DR	R (12) T (4)	E (12) C_S (4)	4.29	12	20	65
BS_3	Missing stair/gallery opening at structural slab	CR	M	C_H	4.83	9	20	45
BP_1	Missing some/all vertical services shafts at some/all architectural plans [a] (7) or vertical services shafts at different places in architectural and plumbing plans [b] (1)	DR	M	C_S (8)	4.71[a] 4.57[b]	8	20	40
BP_2	Insufficient wall thickness for embedding pipes/drains/reservoir	DR	M	E	4.71	5	17	29
BP_3	Insufficient suspended ceiling depth for drains	DR	R	C_S (1) C_H (1)	4.71	2	11	18
BP_4	Window/door partly blocked by vertical services shaft	DR/ CR	R	C_S (1) C_H (1)	4.43	2	19	11
BH_1	Underfloor heating tubes beneath e.g. stair-floor connection, masonry wall	CR	R	C_S	4.17	2	7	29
BH_2	Underfloor heating tubes beneath stud walls	CR	R	C_H	3.29	1	5	20
BH_3	Missing/insufficient underfloor heating system layers in architectural sections	DR	T	C_S	4.14	1	12	8
BH_4	Missing chimney in some architectural plans	DR	M	C_S	4.71	1	7	14
SP_1	Missing some/all services shaft openings at structural plans	CR	M	C_H	4.71	13	20	65
SP_2	Unsolved integration of columns/ loadbearing walls and horizontal supply pipes/drains	DR	R	O (6) C_H (2)	4.00	8	17	47
SP_3	Vertical (4) or horizontal (1) supply pipe/drain or services shaft (3) passing through the beam	CR	R	C_H	4.86	8	19	42
SP_4	Missing (5), additional (1) and/or wrongly located (3) structural components at sanitary area drawings	DR	R	E (4) O (5)	4.71	8	16	50
SH_1	Missing opening at floor slabs for the heating system vertical pipes	CR	M	C_S	4.00	11	14	79
SH_2	Missing chimney opening at structural plans	CR	M	C_H	4.57	4	7	57
SH_3	Chimney (1)/vertical heating pipe (3) passing through beam	CR	R	C_S (2) C_H (2)	4.86	4	15	27
PH_1	Underfloor heating tubes under toilet basin with 'S' trap	CR	R	C_S	4.29	2	7	29
PH_2	Overlapping / too close main distribution pipes		R	C_S	4.43	4	9	44

AR: Architects' responsibility **IT:** Interaction type **IPT:** Integration problem type
PV: Professionals' view information **CP_I:** Projects with integration problem **CP_T:** Projects with relevant
OR: CP_D/CP_T in per cent **DR:** Design/drawing responsibility **CR:** Control/Coordination responsibility
R: Remote **T:** Touching /connected **M:** Meshed **U:** Unified
E: Error **O:** Omission **C_S:** Soft clash **C_H:** Hard clash
**: The number of projects with that specific situation is given in parenthesis when necessary to distinguish*

3.2.1. Architectural and structural systems' integration

The most common problem in the architectural drawings was the position, size or shape difference of structural members (BS_1). Among these, the remote and touching relation counts were close to each other. In all remote relations, the problem was called error, but in touching relations, the construction stages were considered to decide between error and hard clash. The steel sheet's directional problem given in Figure 4-A was called an error for instance, while the upright beam and dropped slab use in Figure 4-B was called a hard clash since the green roof construction would be impossible or difficult if this variation was not noticed before structural member construction. The missing and/or additional beams in architectural sections (BS_2) were the second in line. The missing beams were usually remote from other architectural components, without any clash problem risk (Figure 4-A & B). Thus they were called errors. In touching relations, either there was a wall underneath the beam, or the suspended ceiling was attached to the beam's vertical sides. Considering the construction stages, they were decided to cause a soft clash. Extra beam(s) in some projects

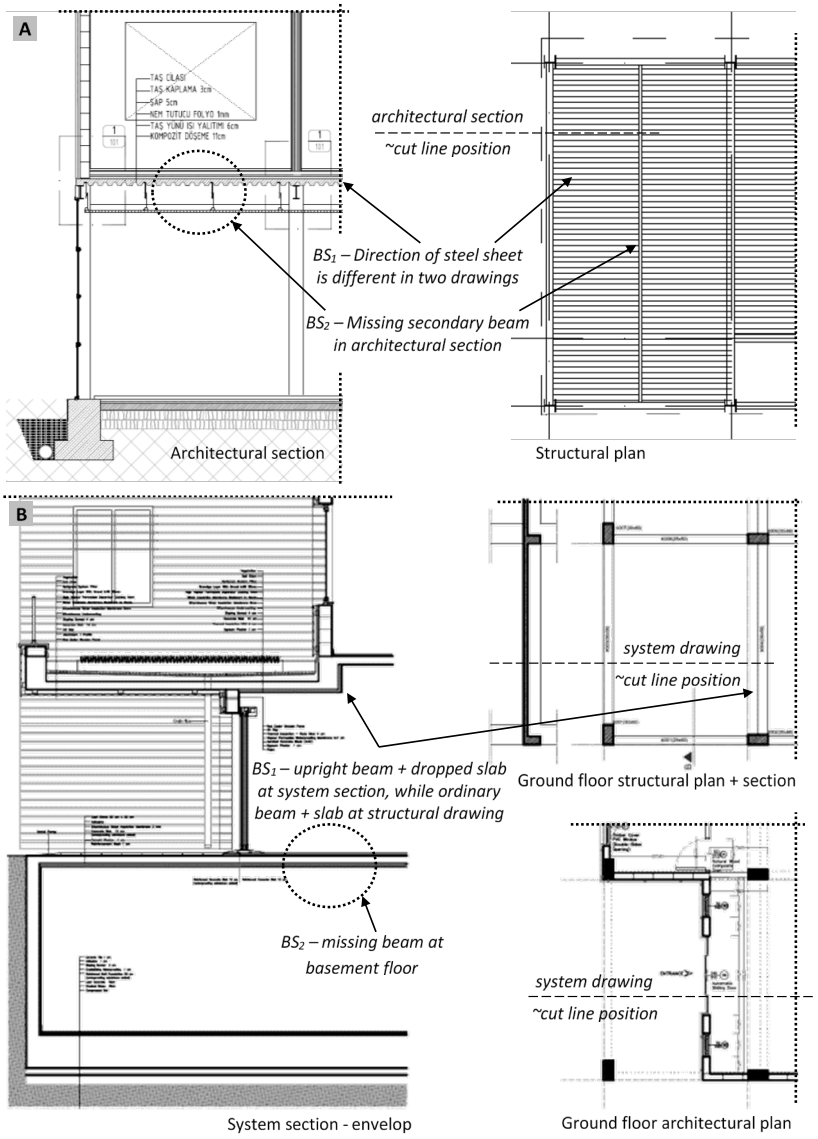

Figure 4: *Examples of BS_1 and BS_2 problems.*

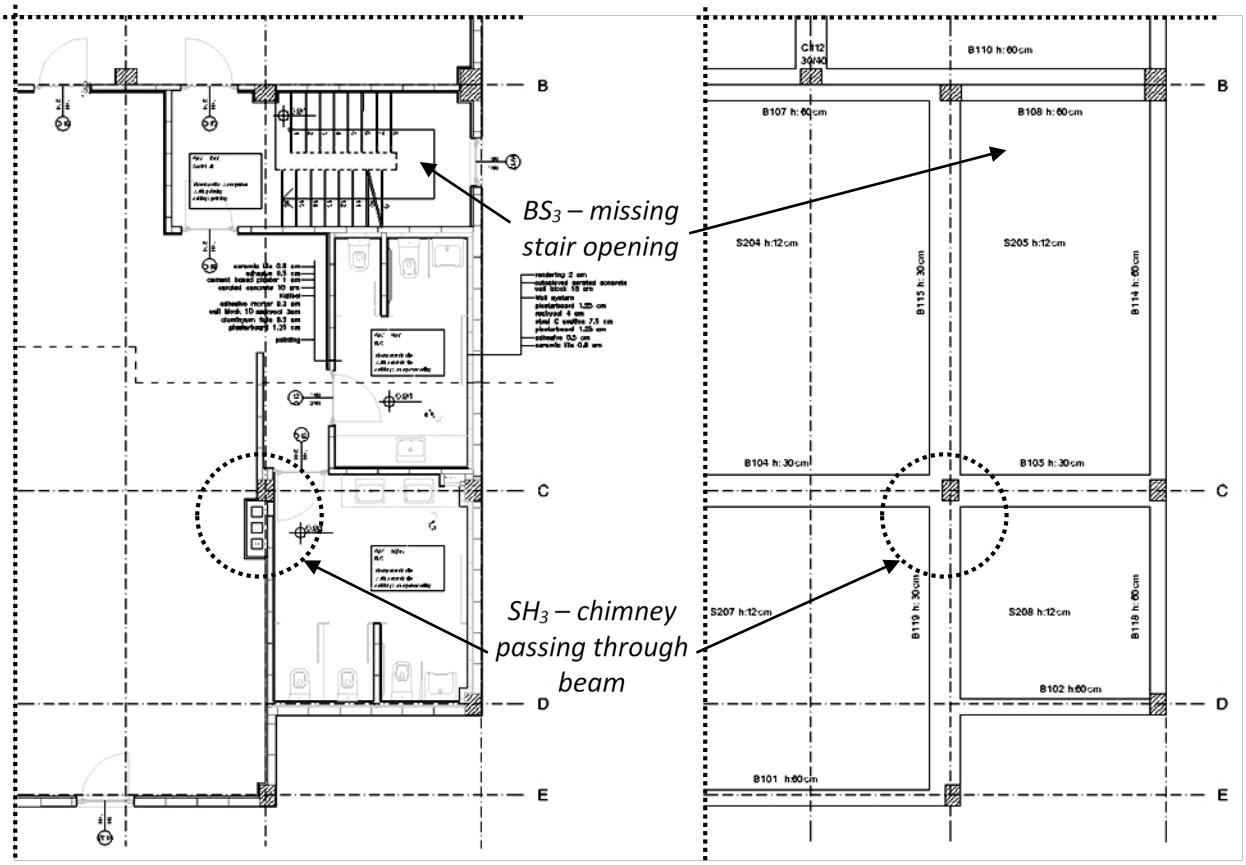

Figure 5: *Example of BS_3 and SH_3.*

were also remote from other architectural elements and thus called errors.

The problem observed in structural drawings was the missing stair or gallery opening (BS_3) with *meshed* interaction. It was called a *hard clash* considering the possible construction delays, when remained unnoticed (Figure 5).

On the whole, errors were the most common, followed by hard and soft clashes respectively. Among these, hard clashes are important concerning their effects on construction time and budget, and most hard clashes were related to the architects' coordination responsibility (BS_3), while cases directly related to architects' design responsibility were fewer. The type classification was also observed to be in line with the professionals' view on their significance, where the response average was the highest in BS_3 causing hard clash always, while it was the lowest in BS_2 causing soft clash sometimes, but without any effect most of the time (i.e. error). The average found for BS_1 causing a hard clash sometimes was between the other two.

3.2.2. Architectural and plumbing systems' integration

The most common problem in architectural drawings was missing or wrong positioning of vertical services shafts (BP_1). To decide whether they were soft or hard clashes, necessary spatial layout changes were considered, and some of them were observed to not affect inter-space organisation or

organisation within the space (Figure 6-A), while others could be avoided by rearranging a limited number of components within that space such as sink or toilet (Figure 6-B). Thus, they were all called soft clashes.

Insufficient wall thickness to embed reservoirs, water supply pipes or drains (BP_2) was the second most common problem. Evaluation of the effect of constructing a second leaf to create the necessary gap for the pipes and drains showed that integrating a second leaf without changing the inter-space organisation was possible in all projects (Figure 7-A). Thus, they were all called errors.

Insufficient suspended ceiling depth to pass drains (BP_3) was the third common problem and to decide whether it would cause a soft or hard clash, the possibility of increasing the depth without changing any other element was evaluated. In the project where that was possible, it was called soft clash, but the one without that possibility due to the room height limitation was called hard clash.

The least common problem was the vertical services shaft blocking a window or door (BP_4). Construction phases and the possibility of changing window/door position were evaluated, and the blocked window within a reinforced concrete shear wall (Figure 7-B) was called a hard clash since its place could not be altered when noticed after shear wall construction. The blocked door in a brick infill wall, whose repositioning was possible without

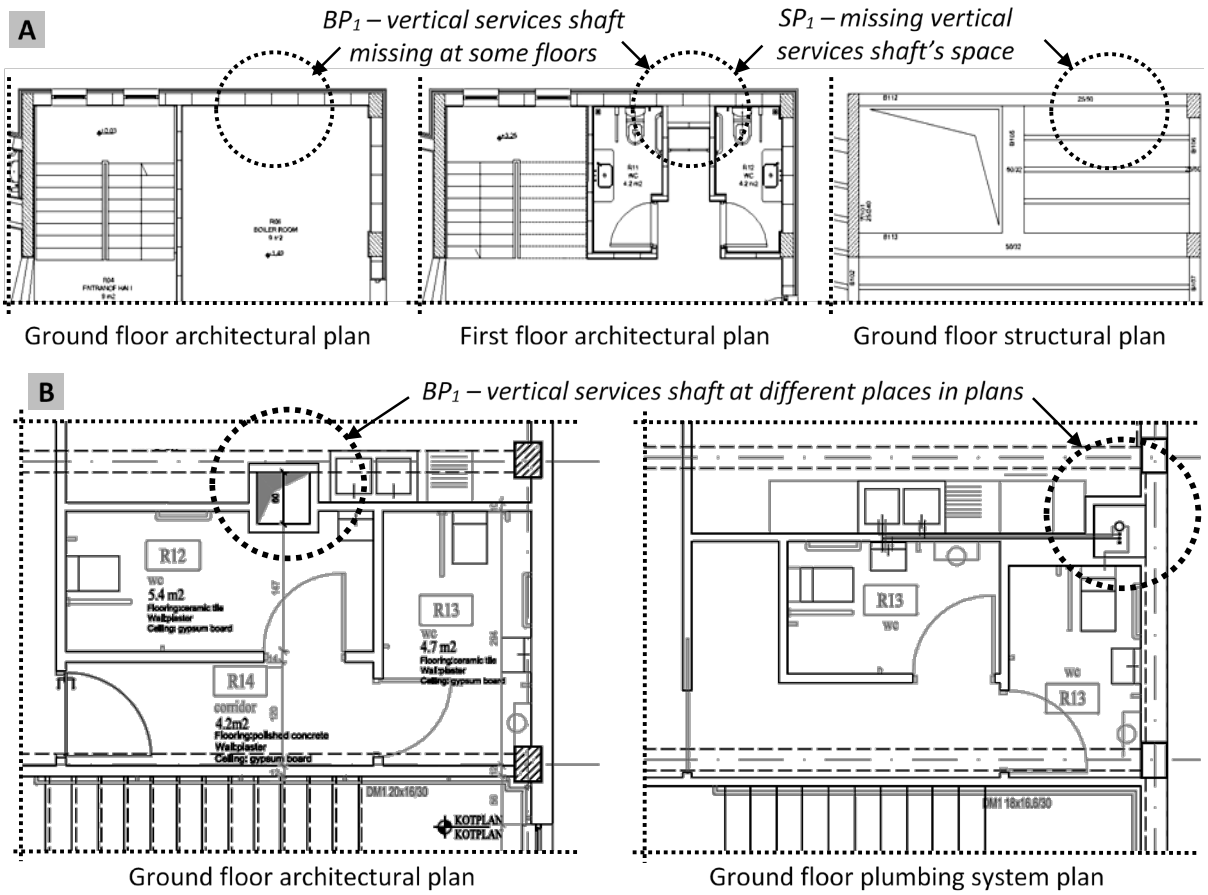

Figure 6: *Examples of BP_1 and SP_1.*

a need for rearranging the interior space, was called a soft clash since the clash problem would most likely be noticed before wall construction.

On the whole, soft clash was the most common, followed respectively by error and hard clash. Soft clashes and errors were observed always at meshed components, while hard clashes were observed, as expected, at systems/components that need to be remote. Additionally, all integration problems listed were directly under the architect's design responsibility, except for BP_4 which could be due to a lack of coordination with the plumbing system designer.

Professionals' opinions on their significance were not in line with the classification, most likely because of the lack of sufficient space in their previous experiences for the necessary rearrangement to avoid the hard clash. In the course, economic issues related to space use were not a design priority, while it is in real-life projects. Therefore, situations observed in students' projects were not as significant as professionals decided considering their previous experiences.

3.2.3. Architectural and heating systems' integration

The problems observed in architectural drawings were mostly related to the underfloor heating system. Tubes passing underneath masonry walls or at floor-stair connection (BH_1) were called soft clash, considering construction stages. Tubes passing under stud walls instead of openings (BH_2) were called

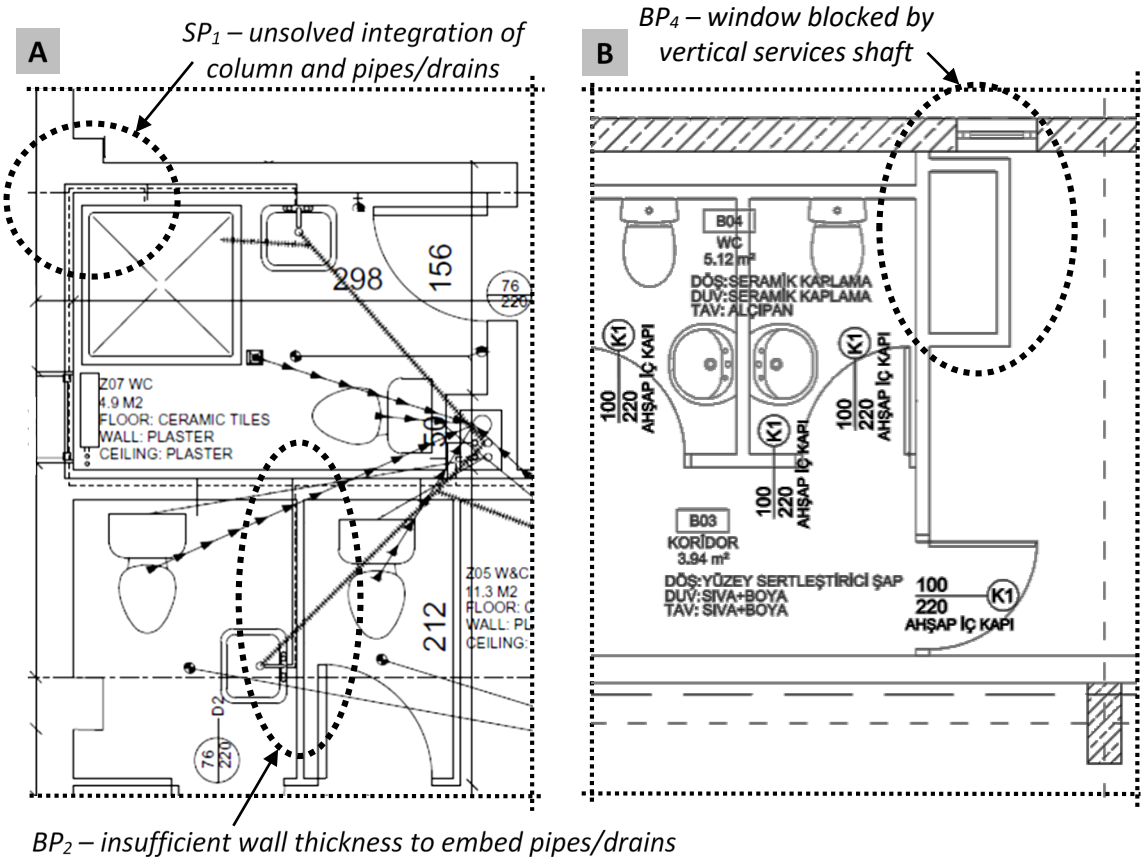

Figure 7: *Examples of (A) BP_2, SP_1 and (B) BP_4.*

hard clash since damaging them while fixing the stud wall's base channel was a possibility. The missing/insufficient underfloor heating system layer in the architectural section (BH_3) was called soft clash since the storey height allowed its correction by increasing screed thickness even when noticed during construction. The last problem, the missing chimney in the architectural plan (BH_4) was seen only in a single floor plan of a project, and it did not cause a redesign need regarding the inter-space organisation when constructed as it should be. Therefore, it was called a soft clash.

On the whole, soft clashes were the commonest with one hard clash only and no errors. It was also noticed that, in systems that need to be remote, both soft and hard clashes can be possible due to the effects of construction sequence and technology preferred, such as observed with BH_2 and BH_4.

Regarding professionals' views, the most significant problem was BH_4, followed respectively by BH_1, BH_3, and BH_2. Among them, type classifications of BH_2 and BH_4 were not in line with professionals' opinions; where a hard clash decision took the lowest point, and a soft clash decision took the highest. The most likely reason regarding BH_4 might be again the space use freedom of students in terms of economic issues. Concerning BH_2, the risk of damaging tubes could be considered low by the professionals as it was explained to be in an isolated area in the survey.

3.2.4. Structural and plumbing systems' integration

The omitted vertical services shaft reservations at structural plans (SP_1) were the most common problem (Figure 6-A). It was called a hard clash considering the likely redesign necessity structurally. The second most common problem was the unsolved integration of

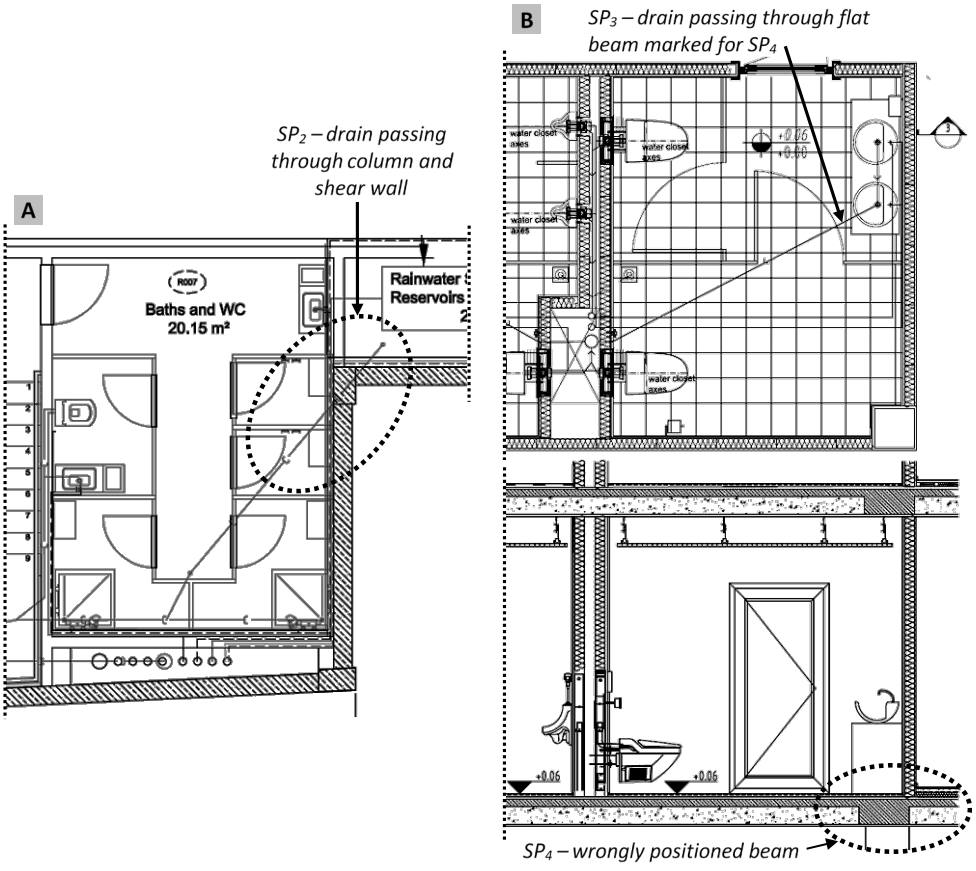

Figure 8: *Examples of (A) SP_2 with hard clash, and (B) SP_3 and SP_4.*

columns/loadbearing walls and horizontal supply pipes/drains (SP_2) in 1/50 plumbing system drawings. Cases with horizontal pipes passing through structural elements were called hard clashes (Figure 7-A and Figure 8-A). Cases with pipes passing in front of structural members without a solution to hide them were called omissions since exposing pipes or drains is not a common practice in Turkey. Supply pipes/drains or services shaft passing through a beam (SP3) was the least common problem (Figure 5 and 8-B) and called hard clash.

In half of the projects with relevant drawings, some beams were either missing or wrongly located or some additional beams were included in 1/20 sanitary area sections (SP_4). An additional beam seen in one project was directly called an error. The wrongly positioned beams seen in three projects would still be remote from pipes/drains when positioned correctly and were therefore called errors. The missing beams seen in five projects, on the other hand, which would again be remote from sanitary components when included properly, were called omissions.

On the whole, hard clashes were the most common, followed by omission, and error respectively. Among the hard clashes, 59% of the cases were related to the architect's control/coordination responsibility (i.e. SP_1). Structural drawings were made before designing services systems, and missing the revision necessity for the final submission was the most likely reason for SP_1. Regarding the architects' design responsibility, unintended meshed connections with the beam were four times more than that of columns/loadbearing walls, showing that drawing students' attention to evaluate the situation in section view is a necessity.

Regarding professionals' views, the two problems decided to cause a hard clash always (i.e. SP_1 and SP_3) had the two highest averages. Therefore, type classification was in line with opinions. However, in SP_2 with a couple of hard clash problems, the opinions were not in line with the classification, and it had the lowest average. Yet, in the survey question, only the unsolved integration was asked without mentioning that pipes are passing through structural members, and this might be the reason for the difference. Regarding SP_4, the relatively high point of 4.71 was not in line with classification without any apparent possible reason and can be questioned in further studies.

3.2.5. Structural and heating systems' integration

Missing openings at structural slabs for the heating system vertical pipes (SH_1) and the chimney (SH_2) in structural system drawings, and a chimney or a vertical heating system pipe that would pass through a beam (SH_3) were the three problems observed. The most common problem SH_1 was directly called soft clash, considering that the opening for pipes is small and can be done after structural slab construction. SH_2 was called a hard clash since it has to be considered during structural design due to its larger size. Regarding the least common problem SH_3, there is a possibility of diverting the vertical heating system pipes around the beams during installation without affecting the interior space much, unless it is a flat beam. Therefore, the former situation was called a soft clash, while the latter situation concerning the flat beam was called a hard clash. This kind of diversion is not possible for the chimney as well, and thus it was called hard clash too.

On the whole, soft clashes were more common than hard clashes, and all of them were related to the architect's control/coordination responsibility. Considering these, it can be said that most students gained the necessary insight to avoid time-csonsuming and cost-increasing hard clashes.

Regarding professionals' opinions, problems related to chimneys causing hard clashes (i.e. SH_3 and SH_2) had high average points, while the one concerning vertical heating system pipes only and causing a soft clash had the lowest. Therefore, it can be said that type classification was in line with professionals' opinions to a great extent.

3.2.6. Plumbing and heating systems' integration

The two problems observed were the underfloor heating tubes passing under the toilet with an 'S' trap (PH_1) and the overlapping or too close main distribution pipes (PH_2). In PH_1, unintended meshed relation can be noticed before installing underfloor heating system components, and tubes can be rerouted to avoid a clash. In the case given in Figure 9 for instance, the sanitary area was over slab-on-grade, and since wastewater drains should be placed before lean concrete, clashes could be noticed before placing heating system tubes. Considering this rerouting possibility, PH_1 was therefore called a soft clash. Regarding PH_2, a more common problem, the space availability to reroute them during installation without changing inter-space organisation was evaluated, and as necessary space was available in all projects, they were called soft clashes. On the whole, considering that there were no hard clashes and both problems were within the architect's control/coordination responsibility, it can be said that most students gained the necessary insight to avoid clashes. Regarding professionals' opinions, the response averages for these problems, both of which were called soft clashes, were close to each other. Therefore, type classification can be considered to be in line with their opinions.

3.2.7. Comparative discussion of integration problem review

Points coming forward regarding the total count and average of each integration problem type observed at each system pair and pairs' interaction types given in Table 4 are as follows:

- Among pairs, the highest occurrence rate was in BS, followed respectively by SH and SP, where the structural system (S) was taking place in all. Concerning the architect's responsibility in these, the cumulative sums of projects containing problems regarding the architects' design

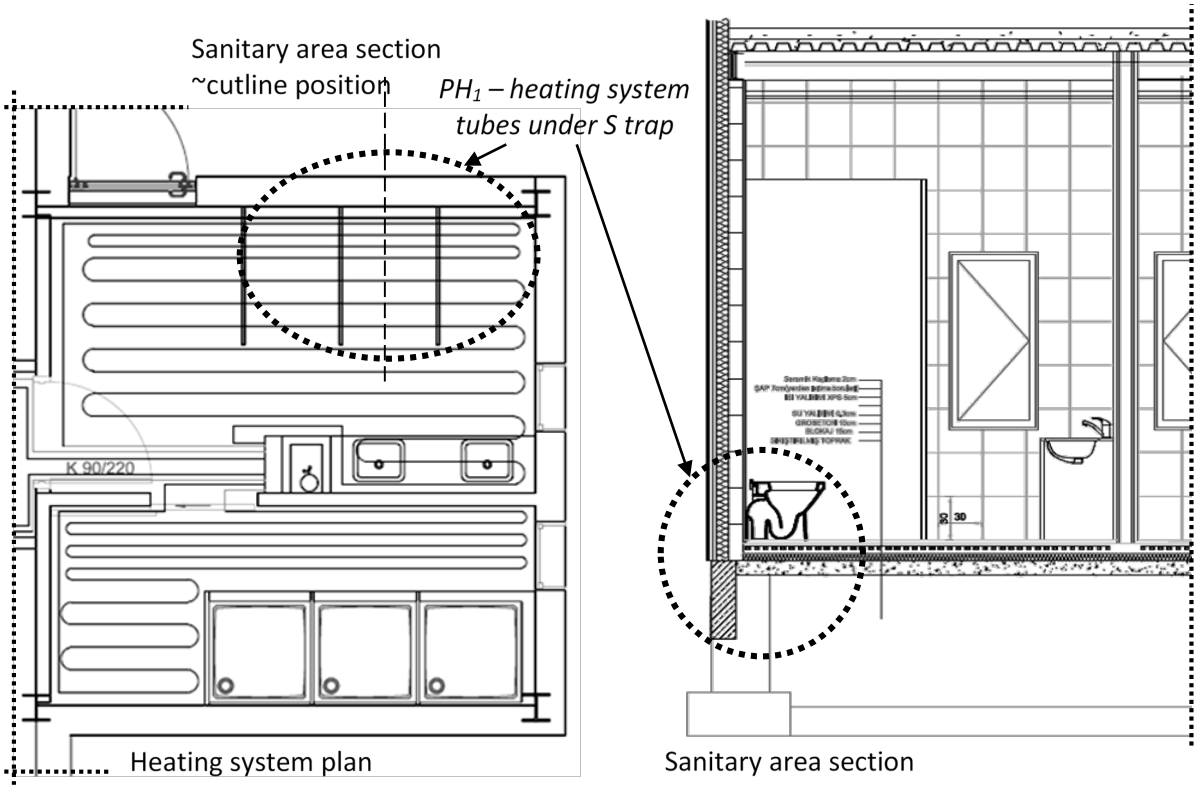

Figure 9: *Example of PH_1.*

duty and control/coordination duty were equal to each other (i.e. 49 in both). The latter shows that students' attention needs to be drawn to the structural systems' importance in producing problem-free projects, in connection with gaining experience in their control/coordination duty in professional life. Regarding architects' design duty, most problems were observed at BS, but within those, errors with less effect on construction time and budget were the commonest. However, as these errors may also cause confusion during construction, it shows that students' attention needs to be drawn to the precision of drawings.

- The occurrence rates in BP and BH were the smallest; 25% and 16% respectively, and nearly all of them were directly within the architect's design duty. These relatively lower occurrence rates show that students gained adequate experience in integrating these disciplines' information/knowledge into their designs.
- NAAB-SPC expects an ability to make proper design decisions regarding the integration and consideration of environmental systems, structural systems, and building envelope systems and assemblies, among others (NAAB, 2019). The total problem count in each project ranged between 2 and 10, and the average was 6.1. The number of problem-free projects in each pair ranged between 1 and 3. When these figures are considered together, problems can be said to be almost homogeneously distributed to the projects. Therefore, considering also the occurrence rate of 43% concerning all pairs together, it can be said that students were successful in the integration of most systems.
- Regarding the components' ordinary interaction, remote and meshed relations were considerably more common than

Table 4: *Overview of interaction types within pairs with deficiency and of integration problem types.*

Pairs	PFP	ΣCP$_T$	IT	Σ IT	Av. %	E		O		C_S		C_H		E+O+C_S+C_H	
						ΣCP$_I$	OR - %	ΣCP$_I$	OR - %	ΣCP$_I$	OR - %	ΣCP$_I$	OR - %	Σ CP$_I$	OR - %
BS	3	59	R	18	47	18	34	0	0	0	7	0	20	34	58
			T	11	29	4		0		4		3			
			M	9	24	0		0		0		9			
BP	3	67	R	4	23	0	8	0	0	2	15	2	3	17	25
			T	0	0	-		-		-		-			
			M	13	77	5		0		8		0			
BH	1	31	R	3	60	0	0	0	0	2	13	1	3	5	16
			T	1	20	0		0		1		0			
			M	1	20	0		0		1		0			
SP	1	72	R	24	65	4	6	11	15	0	0	10	32	37*	51
			T	0	0	-		-		-		-			
			M	13	35	0		0		0		13			
SH	2	36	R	4	21	0	0	0	0	2	34	2	16	19	53
			T	0	0	-		-		-		-			
			M	15	79	0		0		11		4			
PH	1	16	R	6	100	0	0	0	0	6	100	0	0	6	38
			T	0	0	-		-		-		-			
			M	0	0	-		-		-		-			
WP	0	281	R	59	48	22	11	11	4	12	13	15	16	122*	43
			T	12	10	4		0		5		3			
			M	51	42	5		0		20		26			

PFP: Problem-free projects **ΣCP$_T$:** Cumulative sum of CP$_T$ **E:** Error **O:** Omission **C_S:** Soft clash **C_H:** Hard clash
IT: Interaction type **Σ IT:** Cumulative sum of problems observed at each IT **Av.:** Average of Σ IT
Σ CP$_I$: Cumulative sum of CP$_I$ **OR** (Occurrence Rate): ΣCP$_I$ / ΣCP$_T$ in per cent
R: Remote **T:** Touching **M:** Meshed **WP:**Whole pairs
*: In one project, there were two different kinds of interaction problems regarding SP$_4$, and therefore, the sum of deficiencies is different from Σ CP$_I$.

touching relations. The large problem count occurring due to unintended meshed connections between the components that need to be remote is an expected situation. However, the large problem count observed in meshed relations shows that students' attention needs to be drawn more to integration issues in meshed systems/components.

- Among different types of integration problems, the omission was the least common with an occurrence rate of 4%, while that of error, soft and hard clash were higher and close to each other (i.e. between 11% and 16%). Among these, the hard clash has a major effect on construction time and budget, and although it was the most common, the figure was still small, and therefore it can be said that students produced nearly hard clash-free projects.

4. Concluding remarks

Building is a complex system composed of different subsystems with different professions involved in its design. Within this complex process due to various actors, architects, in addition to their design duties, have to direct and coordinate other parties for a properly integrated design solution that will not cause rework and in turn time and budget increase. To this end, students of ITU-DoA practice subsystem integration in the Construction Project course by designing and detailing a small-sized building.

In the article, evaluations performed on 20 final submissions for this course are presented. The main objective was to determine and discuss the design deficiencies and subsystem integration problems. For this purpose, structural, heating and plumbing systems drawings were examined first to determine design deficiencies, classified into two groups; error and omission. Architectural drawings together with the aforementioned ones were then comparatively reviewed in pairs to determine integration problems, classified into four groups; error, omission, and soft and hard clash. Concerning these integration problems, the ordinary interaction between the components was also examined using four interaction types; remote, touching, meshed and unified. Additionally, the opinions of a few professionals on the significance of these integration problems in causing rework were considered while discussing classifications. The following observations were made and concluding remarks were drawn from these evaluations and discussions.

Concerning the design deficiencies;

- In total, 12 deficiencies were identified; five regarding the plumbing system, four regarding the structural system, and three regarding the heating system. Most of them were omissions, such as a missing chimney, rather than errors, like a discrepancy between a plan and its section. However, as a pattern that was found to be similar to those in real-life projects, the occurrence rate of errors in the projects was higher than omissions'.
- The students were more successful in structural system design. Yet, it was observed that the deficiency-free project count in plumbing and heating systems designs could be increased considerably by focusing more on two particular problems.

Concerning the integration within system pairs;

- In total, 20 integration problems were identified. In system pairs with a high occurrence rate of integration problems (i.e. OR >50%), the structural system was always a component of these pairs, although the occurrence rate of design deficiency was the lowest in that system. The cumulative sums of projects containing problems regarding architects' design and control/coordination duties were equal, and errors were the commonest cause of the former. Concerning the latter duty, according to professionals, almost all problems have a very significant effect on construction rework (i.e. >4.5). To increase the number of problem-free projects, stressing more the importance of the structural system in coordination-related problems and the importance of architectural drawings' precision in

design-related problems came forward as an educational strategy.

- Omission was the least common problem with a 4% occurrence rate, while those of error, and soft and hard clashes were just 7-12 points higher. Among these problems, professionals generally rated the problems causing hard clashes as having a very significant effect on construction time and budget (i.e. >4.5). Taking into account both, even the 16% occurrence rate of the hard clash can be accepted to be a sign of producing almost clash-free projects.
- Regarding the ordinary interaction between the components of system pairs, problems were more common in remote and meshed systems than in touching systems. Although the ones related to *remote* systems can be expected, those related to *meshed* systems showed that more attention must be drawn to the integration of plumbing and heating systems' meshed components.

Concerning the objectives of the course in general;

- The smaller rates of *omissions* observed in the design deficiency and integration reviews were accepted as a good sign of gaining the necessary experience in using the knowledge and principles related to structural, plumbing and heating systems in their projects.
- The occurrence rates of errors, and soft and hard clashes observed in the integration review were not too high; ranging between 11% and 16%. These figures were accepted to be a good indicator of gaining the necessary skills and experience in the integration of subsystems.

For future terms, apart from the aforementioned issues, the deficiency and integration problems lists are planned to be prepared as a checklist that can be used in the final submissions. Improvements achieved by using these strategies together with a broader survey among professionals and assessment of integrating effective BIM use in the course can be a subject of future research.

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Ethics Committee Approval: N/A
Author Contributions: The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.
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Students' Perspective of Design Studio Assessment: An Experience in Bangladesh

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Abstract: Architecture education has been based on the design studio model focusing on learning by doing. In this academic program, critique is a vital component and inseparable from studio learning. Although widely practiced, critique has been a neglected area in design education and is often criticized for affecting the students' learning experience. Using a grounded theory approach and mixed-method analysis, this article studies the student's perspective of intermediate assessment and final evaluation of design studio courses in the form of desk critique and jury respectively with a case study of the Department of Architecture at the Military Institute of Science and Technology, Bangladesh. This study uses participant observation involving both the educators as well as learners and a questionnaire survey involving only the students. The results indicate that the learners' and educators' perspectives may not always be aligned. This can be useful to improve the studio-based learning program.

Keywords: Assessment, Critique, Jury, Design studio, Architecture education.

Introduction

In the academic education of architecture design studio is the core of learning and widely recognized for active learning environment (Bailey, 2005; Blair, 2007; de la Harpe et al., 2009; El-Latif et al., 2020; Goldschmidt, 2002; Hassanpour, Utaberta, Abdullah, et al., 2011; Olweny, 2020; Utaberta et al., 2013; Utaberta & Hassanpour, 2012). Originating from the Ecole des Beaux-Arts in Paris, a consequence of the French Revolution-led academic reform, studio-based education in art and architecture emerged with the intent of guiding students in addressing design challenges under close faculty supervision (Alagbe et al., 2017; Bailey, 2005; Salama & El-Attar, 2010). Initially these studios focused on sketch problems that were evaluated in final critique sessions usually excluding student participation (Alagbe et al., 2017; Bailey, 2005).

Until the advent of Bauhaus in the early 20th century, the Ecole des Beaux-Arts held sway as the model for architectural education on both sides of the Atlantic (Bailey, 2005). The Bauhaus school, founded by Walter Gropius in 1919, represented a modernist response to the Ecole des Beaux-Arts. Despite its perceived radicalism, the Bauhaus school shared the fundamental principle of learning through hands-on experience. Scholars often attribute the proliferation of modern-day design studio practices to the influence of the Bauhaus School (Hassanpour, Utaberta, Zaharim, et al., 2011; Lackney, 1999; Salama & El-Attar, 2010). Bailey (2005) believes that the philosophical

underpinnings of academic education have been integral to architecture schools since the early 1960s. Over time, the critique-based assessment introduced at the Ecole des Beaux-Arts has evolved into various formats, remaining a fundamental aspect of studio learning worldwide (Ardington & Drury, 2017; Bartholomew et al., 2019; Belluigi, 2016; Blair, 2006, 2007; Dannels et al., 2008; El-Latif et al., 2020; Goldschmidt, 2002; Graham, 2003; Healy, 2016; Lackney, 1999; Oh et al., 2013; Olweny, 2020; Orr & Bloxham, 2013; Salama & El-Attar, 2010; Schön, 1983, 1987; Smith, 2011).

In architecture education, design studios are concerned not only with characteristics that are appreciated, but also those that need to be refined or rejected; therefore, the studios focus on the process, product and person simultaneously (de la Harpe et al., 2009). This multifaceted challenge amplifies the difficulty of studio assessment in addition to the 'creative' nature of studio exercise (de la Harpe et al., 2009; Orr & Bloxham, 2013). Orr & Bloxham (2013) highlight the complexity of assessment in design fields, where it serves as both an assessment for learning and a concurrent evaluation of the student, their exercise, and the presented work. In architecture education, assessment is inseparable from the carefully cultivated studio culture (Cennamo et al., 2011). Although widely recognized and practiced, assessment is a neglected area in design education and rarely challenged (de la Harpe et al., 2009; Utaberta et al., 2013). However, this research gap is gaining recognition in academia, with increased momentum in the research field.

On this background, this research aims to investigate the design studio assessment of architecture education in Bangladesh. Formal academic education in architecture was introduced in 1962 in Bangladesh. In this long time, there has been very limited research in the field of studio pedagogy and studio assessment is, perhaps, not studied. To fill this research gap, the Department of Architecture in Military Institute of Science and Technology (MIST) was taken as a case study. With a structured investigation of this comparatively new architecture school, this study focuses on the assessment practice and particularly on the students' perspective of the studio assessment.

Literature Review

The primary aim of design studio is to impart essential architectural design skills, although the inherent complexity, influenced by various interconnected aspects, of this process is recognized (Ledewitz, 1985). While established models like analysis-synthesis, concept-test, and conjecture-analysis exist, the widely practiced analysis-synthesis model undergoes contextual adaptation globally (Bamford, 2002; Ledewitz, 1985). This model typically encompasses stages such as briefing, analysis, synthesis, and evaluation. Studio-based learning, aligned with problem-based learning, addresses challenges reflective of real-world professional scenarios (Burroughs et al., 2009; Moody, 2011).

In the realm of studio exercises, the roles of faculty and students often overlap and take different forms, such as such as master, coach, reflective practitioner, critical friend, liminal servant, and analyst (Belluigi, 2016). However, the assessment of studio exercises introduces complexities and often conflicts arise instructors transition into assessors (Anthony, 1991; Belluigi, 2016; Blair, 2006, 2007; Goldschmidt, 2002; Graham, 2003; Oh et al., 2013; Salama & El-Attar, 2010).

Assessment in the design studio is more complicated due to its creative nature and focus and particularly challenging because students are expected to acquire additional capabilities that may not always be assessed with measurable technical solutions (Alagbe et al., 2017; de la Harpe et al., 2009; Orr & Bloxham, 2013; Utaberta et al., 2012, 2013). Despite its complexities, the educational value of assessment in enhancing professional performance is widely acknowledged (Anthony, 1991; Dannels et al., 2008; El-Latif et al., 2020; Olweny, 2020; Salama & El-Attar, 2010).

Studio assessment is usually known as critique, which is also called crit. Crit is perceived in various formats such as desk critique, formative critique, summative critique, peer critique, external critique, group critique, public critique, formal final critique, written critique, online critique, interim review, seminars, panel discussions, and informal interactions (Bailey, 2005; Blythman et al., 2007; El-Latif et al., 2020; Hassanpour, Utaberta, Abdullah, et al., 2011; Utaberta et al., 2013). Desk critique, the most common form of assessment, occurs at the student's desk, for both individually and in group exercises, during the design development phase before the final submission. Formative critique, providing feedback for intermediate assessment, is also widely used. Panel discussions are prevalent in higher education and the final stages of design development, involving participatory discussions where a panel of studio instructors provides feedback. Interim reviews are given to the entire class during the development phase. The final critique, also known as jury or big crit, is a formal evaluation, often conducted as a panel discussion. The jury panel may include external members and experts from the relevant field.

Usually, the studio space is utilized for both intermediate assessment and final jury, some schools often have designated jury space for the grand jury of graduating students. Physical setup of assessment and its impact on the students is not well researched, there are only a few mentions of spatial arrangement (Goldschmidt, 2002; Oh et al., 2013; Olweny, 2020; Salama & El-Attar, 2010; Utaberta et al., 2010). Some studies have argued that the physical setup of assessment significantly impacts students' learning and development (Goldschmidt, 2002; Olweny, 2020). Desk critique, occurring on a one-to-one basis, proves beneficial for student learning and designer development, although it may pose challenges for some students (Goldschmidt, 2002) . Olweny (2020) highlights that the spatial arrangement of a jury reflects power dynamics between jury members and students, while Salama and El-Attar (2010) further reinforces mentioning that the jury setup resembles a trial and this can lead to a defensive role for students and an attacking stance for jurors, potentially escalating tensions. Students, most if not all, feeling intimidated when standing alone in front of the jury is acknowledged (Blair, 2006; Gray & Smith, 2016).

Grading constitutes a crucial aspect of assessment, and the meticulous selection of grading criteria holds equal importance, though grading norms remain understudied in design studio pedagogy (Sadler, 2002, 2005; Utaberta & Hassanpour, 2012). Studios typically pratice holistic grading and analytic grading. Holistic grading, commonly employed in fields like architecture, considers overall quality, proficiency, and understanding when there is no definitive correct answer although faces criticism for potential misjudgment and nonuniform evaluation on the same platform (Mertler, 2001). Analytic grading, also known as criteria-based grading, is favored for its identification of project-relevant criteria, simplified judgment and aiding students in designing accordingly. Yet, defining and communicating criteria are crucial to avoid misalignment and perceived unfairness (Sadler, 2002, 2005; Utaberta & Hassanpour, 2012).

Critique, despite its undeniable educational value in studio learning, is not without condemnation. Desk critique, being more informal, involves instructors taking on the role of a critical friend. However, final jury sessions are often associated with negativity (Blair, 2006; Graham, 2003; Gray & Smith, 2016; Parnell et al., 2007; Salama & El-Attar, 2010). While negativity is not universal, certain students may possess inherent capabilities, some learn how to learn, and others may face 'learning binds,' as described by Schön (1983) – a condition hindering students from progressing in their learning. Studio teaching is itself a matter of designing and it is the task of the studio instructors to nurture all the students regardless of their inherent or acquired abilities, and therefore, careful design of assessment is utterly vital.

Materials and Method

This research followed grounded approach (Corbin, 1990; Strauss & Corbin, 1990, 1997)

and was conducted in two phases. The first phase included participant observation (Spradley, 2016) of design studio courses, desk critique, jury sessions and faculty perspective of studio teaching which developed two hypotheses. These were tested in the second phase through a questionnaire survey with the students. The research was approved by the Research and Development Wing of MIST.

Participant observation

The authors, as faculty members in the Department of Architecture at MIST, conducted participant observation for this research with active participation in the academic environment. The observation spanned two years, covering four semesters, and included 20 faculty members and 8 design studio courses. A total of 53 desk critiques and 24 jury events were observed.

This study broadly aimed to understand, how do the students perceive assessment in the design studio? The answer to this question was first explored with participant observation. Observation topics included faculty conceptualization of studio learning and assessment, physical setting of studios during regular class, assessment and evaluation, desk critique and jury events and students' reaction to the desk critique and jury expressed through verbal communication and physical expression. Faculty conceptualization includes understanding of certain features such as goal of studio learning, dissemination of knowledge, studio modality, stipulation of assessment, distinction between intermediate critique and final jury, considerations about the students' workload, grading criteria etc. In addition to the desk critique and jury events, faculty conceptualization was studied with formal (with semi-structured questions) and informal interviews and group discussions with the inhouse faculty members, guest faculty and invited external jurors. Students' reactions were observed at different occasions, such as during the critique or jury events, in follow-up discussions with the students' feedback on the studio exercise and occasional informal dialogue with the students.

Observation data was collected as field notes and diagrams which were analyzed following the norms of qualitative field research in an inductive way (Denzin & Lincoln, 1994). The steps in the analysis process include preparation of data, coding, categorizing and abstraction(Dey, 1993; Ford, 2004). This phase had led to the hypotheses.

Research objectives and hypotheses

The broader goal of this study was to gain a deeper understanding of students' perceptions of design studio assessments. Specifically, the study aimed to explore the impact of the spatial setup of assessment on students, examine their perspectives on grading, and assess potential differences in their reactions between intermediate assessments and final evaluations. Based on the observation of studio practice, two hypotheses regarding student concerns were formulated and subsequently empirically tested through a questionnaire survey. The hypotheses are outlined below.

- Students feel more uncomfortable in jury. This happens for several reasons, such as the jury setup, stress of evaluation, concern of grade, concern of jurors' critical attitude, anxiety of poor performance etc.
- Students are deeply concerned about grade. They work better with association of score. Therefore, they take intensive preparation for jury.

Online survey and questionnaire design

The second phase involved an online questionnaire survey among the students with Google Forms. The questionnaire was provided to the students' groups for three weeks and they were asked to fill it anonymously to elicit honest opinions, as both the authors and participants were part of the same architecture school as faculty and students. The questionnaire asked about the students' preference for assessment and grading strategy as well as their feelings in critique and jury events. All the questions were designed as structured questions, except one that asked for suggestions to improve the assessment system. Responses were prepared, based on observation and relevant literatures, as Likert items with five levels. The questionnaire was meticulously

designed to exclude any trace of individual identity.

With all questions, except one, structured, employing Likert items with five levels, the sole open-ended question sought suggestions for improving the assessment system. Responses were carefully structured based on observations and relevant literature. The questionnaire was meticulously designed to exclude any trace of individual identity.

Survey respondents

Six batches of participants, comprising one batch of recent graduates and five batches from level 1 to level 5, participated in the survey. The questionnaire was accessible to 126 individuals and 88 responses were received making a response rate nearly 70%. Notably, the response rate was relatively lower from level 1 students and fresh graduates, potentially due to the early stage of the academic program for level 1 and the post-graduation engagements for the fresh graduates. Responses from different groups and gender composition of the respondents are presented in Figure 1.

Statistical tools

Survey responses were analysed both qualitatively and quantitatively aligned with the specific context and relevant literature. Descriptive statistics interpreted the survey results, inferential statistics was employed only to check significant differences between responses.

Statistical analysis for this dataset posed its own challenges. appropriate statistical analysis for Likert scale responses, being ordinal data, was challenging specifically regarding the choice between nonparametric and parametric tests (Sullivan & Artino Jr, 2013). In this dilemma, this study opted for a parametric approach considering the argument by Norman (2010) that that parametric tests are equally applicable to Likert items and yield superior results compared to nonparametric tests.

Result

This section summarizes the observation and survey results regarding the studio practice, physical setup for desk critique and jury, characteristics of the survey respondents, preference of the students for assessment type and grading strategy, students' feelings in the desk critique and jury.

Observation of design studio praxis and faculty perspective

The Department of Architecture at MIST adheres to a traditional studio-based education program, primarily adopting the analysis-synthesis model. Studio exercises were observed to follow a homework-based approach with close supervision from instructors, who provide lectures, presentations, literature, and organize additional sessions like workshops and field visits as needed. Design problems of varying complexity, aligned with course objectives were assigned to the students. Design problems included project requirements, site

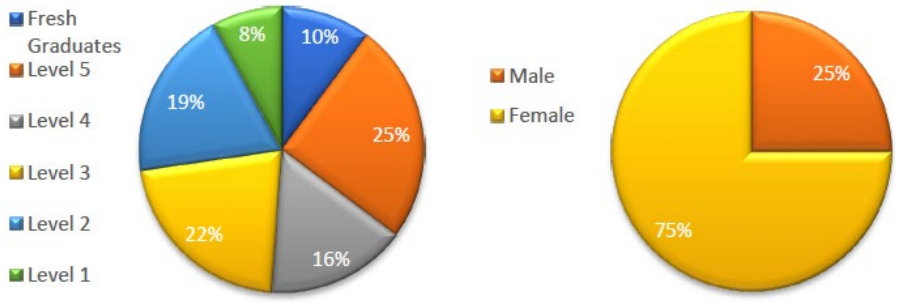

Figure 1: *Batch and gender composition of the respondents.*

conditions, clients' demands, and technical specifications. Students often conducted detailed investigations before proposing solutions, guided by studio instructors who assessed progress through regular desk critiques and final jury evaluation.

Desk critiques were observed to take place at predefined intervals, serving as milestones for the entire studio exercise, focusing on supporting students to develop their design solutions. Such crits were usually graded and targeted specific project segments with clearly identified requirement, rather assessing the whole project. Final jury served as the ultimate evaluation of students' design projects. The faculty often considered jury as a platform for self-assessment of the teaching-learning process, while students considered to showcase their creativity and skills to instructors and peers, fostering lateral learning.

Assessment scoring in studios incorporated both holistic and criteria-based gradings. Holistic grading, offering a quicker method with wider scope and more freedom, was more frequent than analytic grading, involving multi-tiered scoring and rubric design efforts. An example of scoring rubrics for holistic and analytic grading, derived from a level 2 studio project designing an elementary school, is illustrated in Table 1.

Table 1: *Evaluation sheet for holistic and analytic grading.*

Holistic Grading		**Analytic Grading**		
Design criteria	Score	Design criteria	Quality	Score
Conceptualization Functional arrangement Environmental considerations Presentation		Conceptualization • Thematic development • Innovation • Contextual responsiveness	Excellent Good Acceptable Poor Fail	10%
		Functional arrangement • Zoning organization • Classroom design • Circulation pattern • Service efficiency	Excellent Good Acceptable Poor Fail	50%
		Environmental considerations • Classroom environment • Light and ventilation • Indoor-outdoor relationship • Heat gain factors	Excellent Good Acceptable Poor Fail	25%
		Presentation • Composition • Quality of drawing • Quality of model • Oral presentation	Excellent Good Acceptable Poor Fail	15%
Total score	100%	Total score		100%

In the studio practice, the faculty role was observed to be overlapping among atelier coach, reflective practitioner, critical friend and analyst while the role of students can be categorized as collaborator, reflexive practitioner and occasionally emotional/intuitive artist-student. The results of observation are summarized in the following remarks, that had led to the earlier mentioned hypotheses.

- Studio instructors considered the typical classroom arrangement suitable only for desk critique. They emphasize the necessity of a conventional jury setup to facilitate display, delivery, and create an evaluative environment.
- Faculty members preferred holistic grading due to its freedom and scope of assessing a wider spectrum of skills, creative thinking and the intended design project. While acknowledging the benefits of analytic grading, they occasionally practiced it.
- A faculty consensus existed on the belief that all forms of assessment, particularly jury, significantly benefited students and facilitated knowledge dissemination, with critical thinking development as a key learning goal.
- Faculty recognized the educational value and potential adverse effects of assessments on students' learning experiences. They accepted certain degree of informal assessment and advocated for formal jury sessions to induce stress, fostering hard work and preparing students for the demanding professional world.
- Disagreement persisted among faculty regarding the structure, organization, and norms of assessment, specifically for jury sessions, with a perception that set norms and criteria were not absolute necessities.
- Drawing on the professional or study experiences in other architecture schools in Bangladesh, many faculty members considered the overall academic environment, particularly the jury setting, to be friendly and supportive to students compared to many other schools.

Physical setup for desk critique and jury

In the final jury, the students, typically, submitted their design with all required elements, such as presentation drawings, models, technical details, investigation report etc. requiring ample display area. MIST allocated a distinct jury space specifically designed for the grand jury of graduating projects. This space was occasionally utilized for regular studio project juries at the discretion of the studio instructors. The physical setup of studios accommodated drafting tables, stools, display boards, audio-visual facilities, computers, internet connections, storage areas, and conventional demonstration arrangements like whiteboards, daises, rostrums, document cameras, and working desks for studio

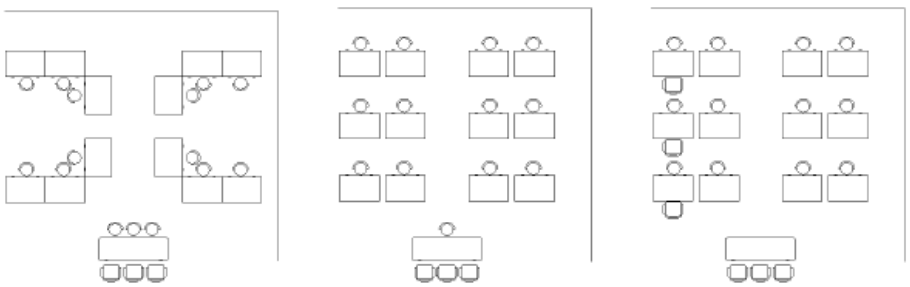

Figure 2: *Desk critique arrangements, in group work students come to instructors (left) and in individual work either student comes to instructors (middle) or instructors go to student (right).*

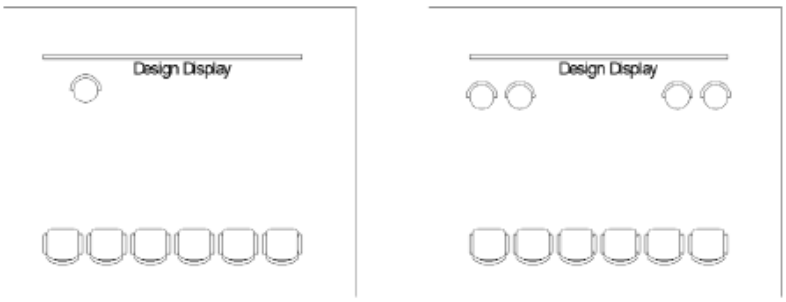

Figure 3: *Jury arrangements for individual (left) and group (right) projects.*

instructors. Students could arrange the physical setup in their studios, facilitating various activities such as model making, design discussions, and displays for assigned projects, as well as providing space for interaction, socialization, or recreation. Figure 2 and Figure 3 illustrate physical arrangements for desk critique and jury, while Figure 4 depicts a jury session for graduating students and a regular studio.

It was observed that the regular studio setup remained unchanged for desk critique, with occasional minor adaptations to accommodate specific design exercise needs, such as multimedia presentations, large models, long drawing sheets, installations, or special elements like fire, water, lighting arrangements, and performances. Final jury sessions were almost always had conventional setup. These sessions were open for other faculty members and students, with occasional participation from faculty and students from other departments and schools. The jury environment was observed to be formal, compared to the desk critic, and the students exhibited some tension. However, faculty and external jurors perceived the jury environment as cozy, friendly, and supportive.

Students' preference for assessment and grading

The survey aimed to understand students' perspectives on assessment methods that aid their design development. Despite varied assessment methods, there was no preference, suggesting that all forms contribute to design development. Notably, support for desk critique slightly exceeded the final jury. Students showed a preference for desk critique without grades, indicating concerns about grading, as such critiques allowed for necessary corrections and further design development without

Figure 4: *Ongoing jury of a graduating student (left) and a regular studio (right).*

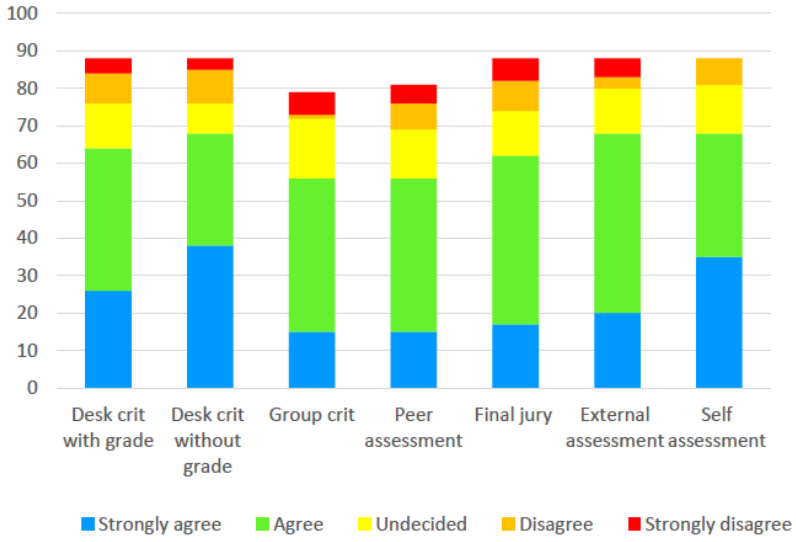

Figure 5: *Students' preference for assessment that help them for design development.*

affecting the final grade because the final grade usually considered the assessment scores. Survey responses also highlighted students' reliance on self-assessment and peer assessment acknowledging lateral learning, confidence building, and enhanced critical thinking abilities. Figure 5 visually represents the students' responses.

Regarding grades, the faculty perception was not reflected in the student responses. Students reported almost equal frequency of holistic grading and analytical grading in studio and a remarkable preference for analytical grading supporting their concern for grade. Figure 6 portrays the survey responses.

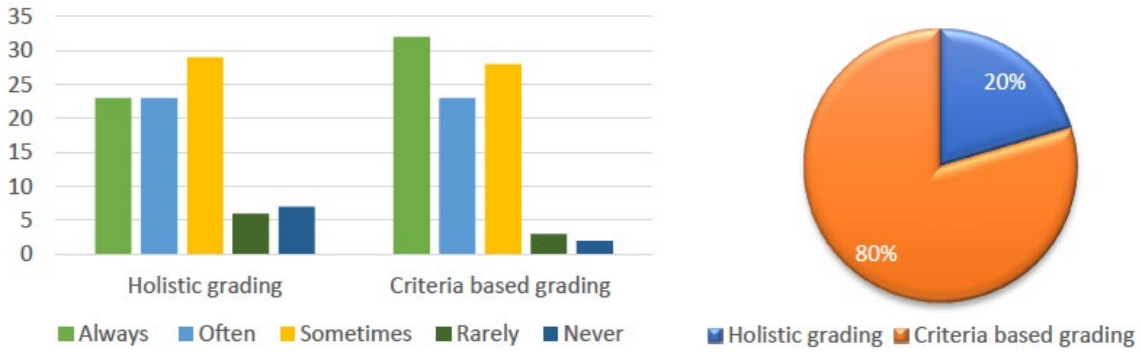

Figure 6: *Grading practice in studio courses (left) and students' preference (right)*

Students' Reaction to Desk Critique and Jury

A major concern of this study was to distinguish the students' feelings in the desk critic and formal jury. This was asked with a simple question, 'How do you feel in the desk critique/jury?' with 14 structured responses based on similar studies (Blair, 2006; Blythman et al., 2007; Graham, 2003; Hassanpour, Utaberta, Zaharim, et al., 2011; Orr & Bloxham, 2013; Salama & El-Attar, 2010; Smith, 2011) with five frequency levels always, often, sometimes, rarely and never.

Although, desk critic was perceived, by the educators, to support the students, the survey responses yielded intriguing trends. Positive spirits were notably diminished, with students feeling less appreciated and encouraged during critiques. However, they demonstrated a clear willingness to try new things and openness to feedback despite confusion, nervousness, and frustration. Survey results are presented in Figure 7.

Regarding the final evaluation, the survey responses were aligned with the observation. A higher proportion of students expressed feelings of nervousness, disappointment, and frustration compared to those who feel appreciated, inspired, and confident. Yet, a glimmer of hope as students demonstrated willingness to take advice Survey results are illustrated in Figure 8.

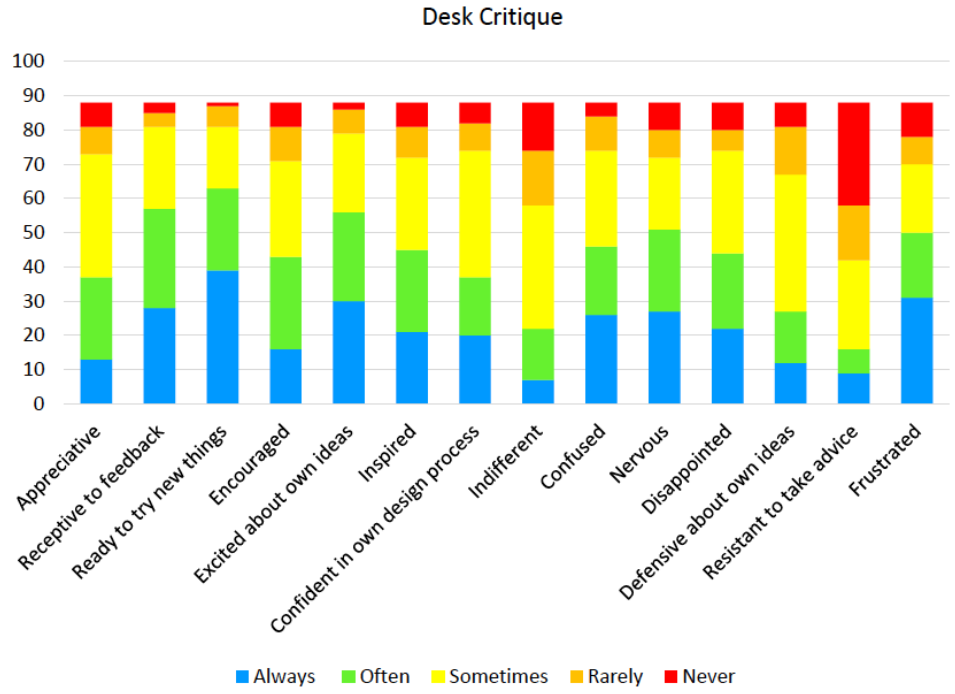

Figure 7: *Students' feeling in the desk critique sessions.*

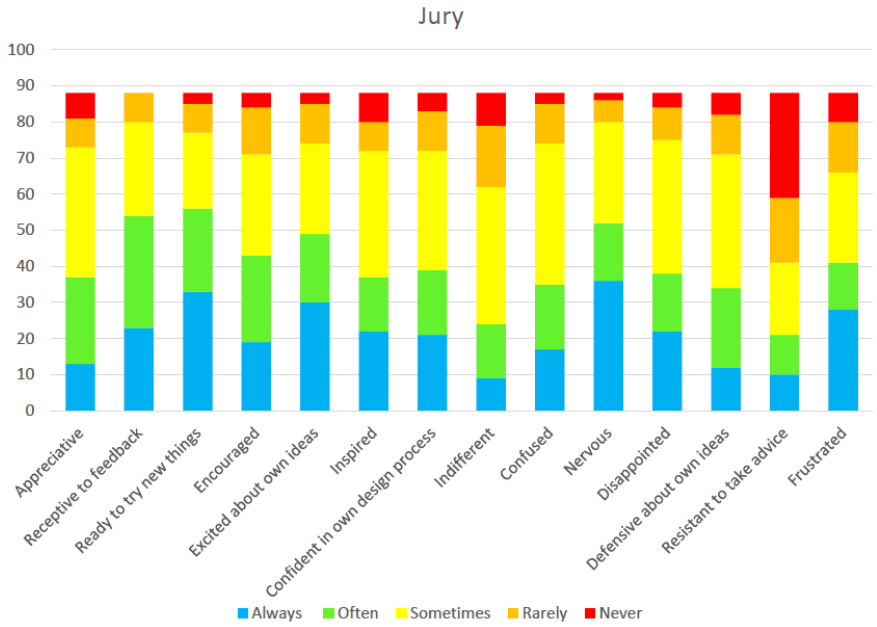

Figure 9: *Students' feeling in the final jury sessions.*

The research hypothesis postulated that students would likely feel more confused, nervous, disappointed, and frustrated in jury sessions compared to desk critiques.

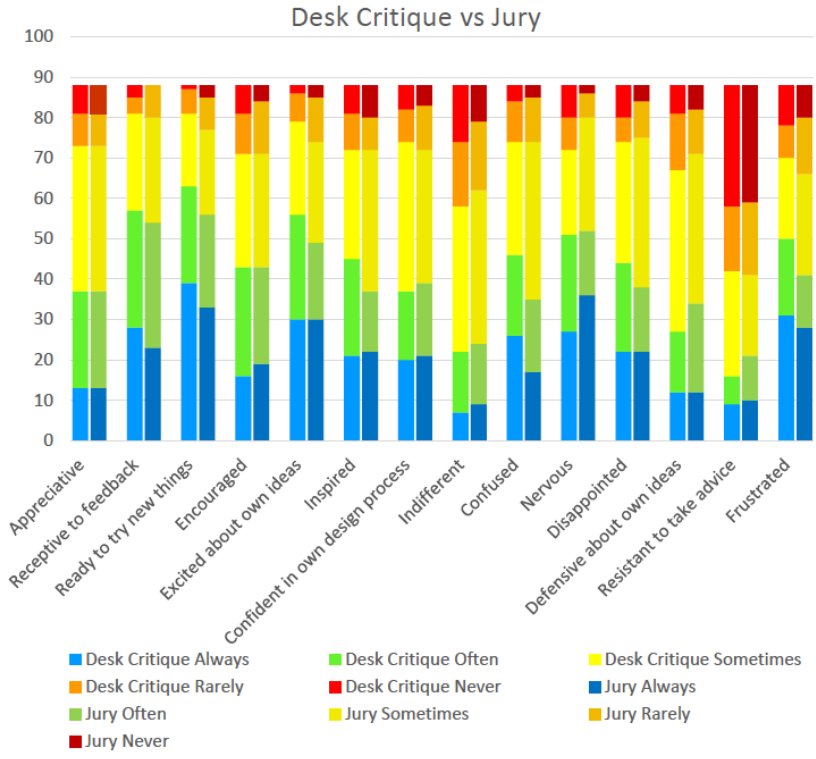

Figure 8: *Comparison between students' reaction in desk critique and jury sessions.*

Surprisingly, the survey results did not support this assumption, revealing minimal variation between the two datasets and the responses appeared almost identical. A visual representation of the survey responses is depicted in Figure 9.

To assess the statistical significance of this marginal difference, a parametric test was conducted, following Norman's suggestions (2010). Frequencies were counted, and a contingency table was prepared for each category, treating them as interval data according to Likert scale norms. A 2-tailed paired sample t-test was performed for each category, with a significance level of $\alpha = .05$. The results, as presented in Table 2, designated that the difference between responses for desk critique and jury was not statistically significant.

Discussion

Testing the hypotheses formulated from observation data yields interesting results in this study. Survey responses on various topics are interrelated and should be considered holistically. Contrary to the assumption, students perceived both desk critique and jury sessions with nearly equal intensity. This finding is interconnected with the other observed trends.

Firstly, the impact of the jury setup on students seems minimal. Despite studies suggesting potential unfavorable effects, survey responses indicated equal discomfort and positive spirit in both jury and desk critique settings. However, this research did not consider jury in other different setup and therefore further investigation is recommended, perhaps employing different spatial setups for juries to explore potential impacts on student performance and jurors' attitudes.

Secondly, students expressed a clear preference for analytic grading, contrasting faculty preferences for holistic grading. This discrepancy is possibly driven by students' concerns for grades, which was also evident in

Table 2: *Statistical comparison between deck critique and jury*

Reaction	Always		Often		Sometimes		Rarely		Never	
	Crit	Jury	Crit	Jury	Crit	Jury	Crit	Jury	Crit	Jury
Appreciative	13	13	24	24	36	36	8	8	7	7
Receptive to feedback	23	28	31	29	26	24	8	4	0	3
Ready to try new things	33	39	23	24	21	18	8	6	3	1
Encouraged	19	16	24	27	28	28	13	10	4	7
Excited about own ideas	30	30	19	26	25	23	11	7	3	2
Inspired	22	21	15	24	35	27	8	9	8	7
Confident in own design process	21	20	18	17	33	37	11	8	5	6
Indifferent	9	7	15	15	38	36	17	16	9	14
Confused	17	26	18	20	39	28	11	10	3	4
Nervous	36	27	16	24	28	21	6	8	2	8
Disappointed	22	22	16	22	37	30	9	6	4	8
Defensive about own ideas	12	12	22	15	37	40	11	14	6	7
Resistant to take advice	10	9	11	7	20	26	18	16	29	30
Frustrated	28	31	13	19	25	20	14	8	8	10
p value	.718025		.139595		.084376		.028704		.020932	

their preference for desk critique without grade. Faculty perception was observed that that analytic grading results in higher score than holistic grading, probably the students also believed the same, further research could probe into exploring these discrepancies.

Thirdly, the unexpected finding arises from comparing desk critique and jury sessions. Contrary to faculty perceptions and existing studies, survey responses indicated almost equal sentiments, with no statistically significant differences. Despite recurrent mentions of tense jury environments negatively impacting students, the survey revealed similar levels of worry and positive spirit for both settings. Possible explanations include the supportive jury environment acknowledged by faculty and external members. This suggests for comparative studies with other schools to explore the impact of jury attitudes on the learning experience. Another factor could be the influence of desk critiques, which, as part of MIST's continuous assessment strategy, take place multiple times before the jury. This frequent exposure helps students to build confidence and refine their projects, making them less likely to feel nervous and confused during final jury. This suggests an interesting topic of research, if the number of intermediate assessments has any impact on the jury performance of the students. A logical explanation is students' concern for grades; MIST's practice of assigning grades for all critique sessions and a maximum of 50% of the final jury grade to the cumulative project grade underscores students' serious approach to desk critiques. This grading practice is intended to ensure the project's authenticity and prevent 'Pinterest submission' or 'expat submission' in juries. This is an interesting finding; it will be a very inquisitive topic to know what the case with different composition for final project grade could be. Lastly, the similarity in sentiments between desk critique and jury sessions might be a chance occurrence, although such a possibility is limited.

In conclusion, one hypothesis regarding students' concern for grades holds true, while the other, suggesting greater discomfort in jury sessions, is contested. Empirical data indicate that students feel equally uncomfortable in both desk critique and jury sessions. This is important to understand the underlying reasons behind the worries to improve the assessment practice. Although the survey responses show a mix of emotions, the feedback on improving assessment practices reveals a glimpse of some students' intimate feelings and very emotional estate of mind which appears to be, unfortunately, gloomy.

Similar studies are found in other counties, for example in Malaysia (Hassanpour, Utaberta, Abdullah, et al., 2011; Hassanpour, Utaberta, Zaharim, et al., 2011), Nigeria (Alagbe et al., 2017), Egypt (Salama & El-Attar, 2010), Kenya, Tanzania and Uganda (Olweny, 2020), Australia (Ardington & Drury, 2017), UK (Blair, 2006), USA (Graham, 2003) etc. While not all studies are on the same scale, qualitative comparisons suggest that the situation at MIST appears relatively brighter. Students here receive multiple intermediate assessments that contributes to design improvement along with fostering confidence, critical thinking, and overall grooming as a designer.

Conclusion

This research attempts to understand some features of the complex design studio pedagogy in architecture education, using MIST as a case study, and unveils several noteworthy insights. Firstly, there is no explicit evidence of any impact of jury setup significantly impacting students. Secondly, students demonstrate seriousness and preparation for both desk critique and jury, with an indication that multiple critique sessions positively enhance design quality and confidence. Thirdly, it appears that grade plays as motivating factor for students in studio exercises.

Moving forward, the findings raise new questions and widen the scope of additional research involving multiple schools and varied issues such as spatial arrangements, juror attitudes, grading compositions, number of critique session etc. While these findings open avenues for further exploration, certain limitations must be acknowledged. The

research focused solely on one school, limiting direct applicability, and therefore generalization should be approached with consideration for contextual differences. Being non-experimental and reliance on events that have occurred compromises its ability to explain results in diverse situation offering plausible correlations rather than causation.

The insights garnered from this study, considering MIST as a case study, can be valuable for this institution and also for other architecture schools in Bangladesh and neighbouring countries that follow similar design studio-based program. This may contribute to various issues like studio evaluation, students' motivation, workload, and stress management, building confidence, grooming etc. and is expected to contribute for a comprehensive understanding of architecture education's pedagogical landscape.

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CAD Inspiration for Design Students on the Geometric Modification of Letters

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Abstract: This study explores geometric modifications in letter design to encourage originality among elementary design students. It emphasizes viewing Computer-Aided Design (CAD) as a tool for boosting students' inspiration and familiarity with innovative letterforms. The study equips students with skills to create original designs and navigate copyright issues related to the use of typeface for their project. To achieve its objectives, the study targets: identifying challenges faced by design students, illustrating geometric modifications, developing procedures to encourage creativity, and evaluating the effectiveness of these procedures. An exploratory method is employed, involving focus groups with ten participants each, utilizing CAD for geometric modifications of existing and original design, and applying the semantic differential scale (SDS)/Likertscale to assess perceptions and efficacy of the suggested procedures. Both descriptive (mean, standard deviation, bar charts) and inferential statistics (chi-square, independent sample t-test, one-way ANOVA) are used in the analysis. The findings highlight gender issue, challenges related to inadequate access to technology and demonstrate CAD's effectiveness in enhancing geometric modification processes. The study emphasizes the significance of understanding anatomy and design principles, particularly in original designs created from scratch, underscoring CAD's role in reinforcing these principles. The outcome shows that students can independently create display and decorative letters for various applications without relying entirely on already existing one for originality purpose. Suggested procedures, including drafting design briefs, seeking mentorship, and integrating CAD with manual techniques, are found to enhance creativity and originality. Thus, it is likely that the suggested procedure has significant effect on the student's creative letter design especially when the elementary design students are flexible and not when they are unyielding. The combination of CAD and manual techniques notably improves students' intuition and creativity in letter design, with the overall positive impact on their creative output.

Keywords: CAD, Copyright, CorelDraw, Computer font, Creativity, Design Students, Geometric Modification, Graphic Design, Letter design, Originality, Typeface

Introduction

In regions where the digital gap persists, access to type design programs is often limited. The assumption that hand-drawn letters are the simplest form of type design would seem advantageous in such areas, but unfortunately, this is not the case (Corel, 2024). The main issue lies in the scarcity of digital resources, which are either inaccessible or prohibitively expensive. In more developed communities where the digital gap is minimal or nonexistent, individuals can readily access technology for creating typefaces directly on computers. However, this advantage is often absent in regions still grappling with the digital divide. Instead of criticize the government for inadequate digital resources to help students in this type of situation, this study addresses an

infinitesimal aspect of these challenges by exploring geometric modifications in letter design to encourage originality. In this study, students are given the freedom to employ any techniques they prefer for their creative exercises to avoid factors that may limit their creativity and interest. However, computer applications such as CorelDraw are utilized by the author as instructional tools to demonstrate modifications in letter design. It is believed that this process may inspire students and increase their interest while familiarizing them with letterforms.

A lack of widespread information results in many individuals being unaware of free programs available for creating typefaces. While some regions possess a basic understanding of intellectual property, comprehensive knowledge is often deficient. It is notable that educational institutions that include copyright and originality in their curriculum frequently fail to effectively convey these concepts. Additionally, the ease with which text and images can be duplicated using computer applications diminishes the incentive for originality, causing students to rely on existing resources rather than creating their own, ultimately leading to a lack of personal identity in their work. To address these challenges, this study considers geometric modifications in letter design to foster originality. Navigating copyright issues related to typefaces and fonts remains problematic for many (Althubiani, 2023). The terms "typeface" and "font" often cause confusion, complicating the process of seeking permission to use these intellectual properties. Although typeface designs themselves are not protected, the software enabling the use of fonts—including font files (e.g., TrueType or OpenType) and rendering code—is subject to copyright protection (Althubiani, 2023). However, some fonts are released under open-source licenses, permitting free use, modification, and distribution. Designers can also modify type after converting it to outlines (ETalks.23927486htvk, 2022). Building on this foundation, this study presents an exploratory prototype on Computer-Aided Design (CAD) inspiration for undergraduate students, with a focus on geometric modifications in letter design to promote originality

The rationale behind this study is to encourage students to view Computer-Aided Design (CAD) as a tool akin to their sketchpad and pencil, fostering confidence in their intuition and reducing reliance on copyrighted materials. CAD can be inspiring due to the various ways it can be used to imagine design beyond what the mind has initially conceived. Though it might seem playful; sometimes, this inspiration may make design to eventually drift from initial sketches when considered better or more innovative than initial mindset. Through this means a student is expected to see other different interesting ways of doing their design works. This is referred to as CAD inspiration in this study. As design students, CAD should inspire them to explore various possibilities of unique letter design, especially when integrating sketches with CAD for experimentation or modification of letterforms. Historically, books were handwritten by scribes around the fifteenth century, emphasizing the relevance of hand lettering as the foundation for typeface design. Understanding this historical context and engaging with CAD software can enhance students' familiarity with letterforms and nurture their creativity while upholding copyright and licensing principles.

Ultimately, this study advocates for a comprehensive approach to type and letter design, recognizing them as forms of visual communication with distinct purposes. By equipping elementary design students with the skills to create original designs and navigate copyright issues, this approach prepares them for careers in type design while respecting the rich tradition of hand lettering for communication. In type design, students may initially lack ideas, thus it's necessary to study established existing letterforms or typefaces to generate new ideas. Knowledge of letter anatomy should enable students to create various prototypes based on different strokes, terminals, serifs, bowls, counters, and other features. Thus, this study presents an exploratory and prototype study on Computer-

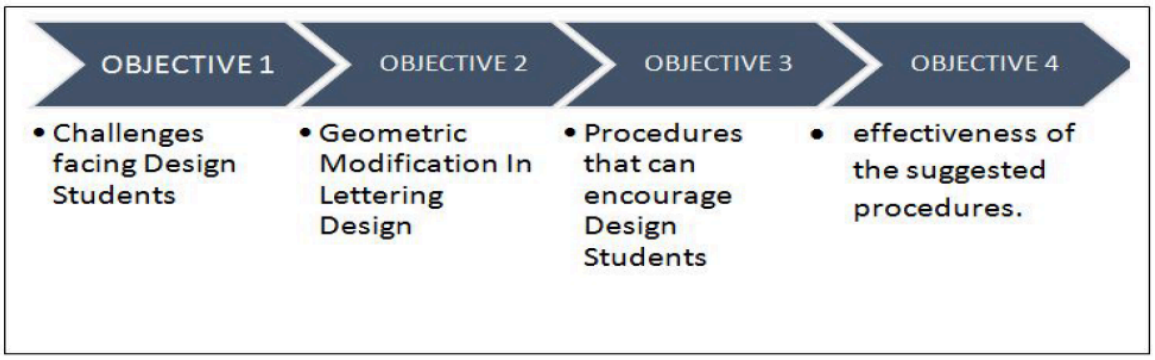

Figure 1: *Integrated diagram for the study*

Aided Design (CAD) inspiration for undergraduate students on geometric modification in letter design for originality purposes, outlining four specific objectives as briefly shown in Figure 1.

Aim and Objectives

The aim of this study is to explore CAD inspiration for design students on the geometric modification of letters for originality purposes.

The specific objectives are to:

I. investigate challenges facing students in letter design or typographic design works in relation to the limited digital resources;
II. illustrate geometric modification in letter design;
III. suggest procedures that can encourage apathetic students to becoming motivated or inspired to seek originality in design project particularly in letter design; and
IV. assess the efficacy of the suggested procedures in fostering originality among students in their design project particularly in letter design.

Literature Review

The study of letters as symbols representing speech sounds is integral to the evolution of human communication, marking a significant milestone in civilization's quest for effective interaction (Sari and Prada, 2020). Despite the prominence of images and digital advancements in printing, written words remain the cornerstone of information dissemination. Proficiency in lettering is indispensable for those involved in crafting communications for both traditional and digital mediums (Willen and Strals, 2009). Prior to 1450, all letters were painstakingly handwritten, until Johannes Gutenberg's invention of the printing press revolutionized the dissemination of written material, ushering in a diverse array of typefaces that are still in use today (Mills and Weldon, 1987; Chapman, 2020).

According to Cheng (2006), hand-drawn letters can be scanned and traced to create digital character outlines, or they can be sketched directly on a digital screen or sketchpad. In some schools, sketching typefaces on a computer is now common, while in other schools, particularly in third-world countries, this practice is less known or affordable due to the lack of digital resources (Boss, 2018). While digitization has brought about significant advancements, it is crucial for scholarly attention to remain focused on this area. A minority of design schools possess the necessary digital resources, which are often inaccessible or prohibitively expensive. If digital utilities such as Adobe Streamline, Pyrus ScanFrost, or DTL TraceMaster are used in developed countries while many schools in underdeveloped or developing countries cannot afford them, a barrier in design education emerges. This barrier prevents the widespread dissemination of knowledge. Consequently,

students in regions where the digital divide persists may not be familiar with specialized font software like FontLab, Fontographer, Robofont, or DTL FontMaster. In such situations, these students lack the opportunity to fully learn and utilize this software. "Today, however, most of those working with typography have little education in type, including, with few exceptions, most designers (although some of the better design schools are beginning to address this important subject). The unfortunate result of this situation has been the proliferation of poor typography" (Strizver, 2006; p.25). According to (Strizver, 2006), these led to the democratization of type design but contributed to the quality of these typefaces ranging from very high end to extremely poor, leaving the daunting task of deciphering “which was which” to the end user. Even, some designers find some of the software like DTL interface difficult to learn (Cheng, 2006).

Previous literature, including works by Eramudugolla and Samarawickrama (2023), Bojan and Uroš (2012), Chapman (2020), Willen and Strals (2009), Mohsen and Sayegh (2018), Fleischmann (2011), Oluyemi et al. (2022), Cheng (2006), Turgut (2014), and Mills and Weldon (1987), has touched upon various aspects of type and letter design. Elias et al., (2023) consider safety, functionality, usability, pleasurable experience, and individuation as users' need when considering typographic properties and accessibility, legibility, readability, personality, and customization as properties of typography. For instance in terms of typographic properties, open aperture helps readability because they are less confused with letter "O" (Cheng, 2020). Sharma et al., (2023) in their study, create an intent- driven system to provide contextual font recommendations to users to aid creative design. Wang et al., (2015) used deep font system for font recognition as well as produce a font similarity measure for font selection and suggestion. However, there is a notable gap in literature concerning the enlightenment of students through CAD-inspired geometric modifications of letters. Design students should continually explore various typefaces to build upon existing knowledge. For instance, Eramudugolla and Samarawickrama (2023) proposed a draft typeface for Sri Lankan Directional Informative Sign Boards, addressing the dearth of literature on Sinhala script or Sinhala typography. Similarly, Prasad, Mishra, and Prasad (2018) suggested a simplified standard method for constructing uppercase letters to alleviate confusion among engineering students and professionals. They noted that software packages like AUTOCAD could aid in constructing Gothic letters. Bojan and Uroš (2012), in their study on font hinting techniques for high-quality font display, emphasized the importance of understanding letter anatomy and the fundamentals of digital typography for well-designed fonts. Hinting is the last stage for the production of professional font by equalizing the design elements to appropriate number of pixels (Cheng, 2006). It can also ensure consistent alignment of the design elements.

Figure 2, extracted from the research conducted by Bojan and Uroš (2012), illustrates the intricate arrangement of nodes along the line segments of specific letters, highlighting notable similarities and differences. This aspect serves as a fundamental underpinning for

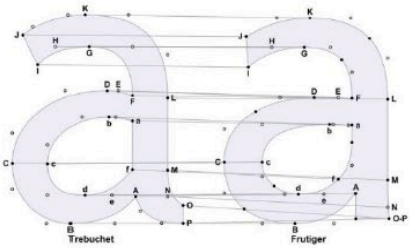

Figure 2: *Nodes on letters to understand both automated and manual techniques. (Bojan & Uroš, 2012)*

comprehending advanced research in both automated and manual techniques. Consequently, this study extends upon this foundational knowledge by introducing CAD inspiration for design students, particularly in the realm of geometric letter modification. It is worthy of note that present study is not about font modification but letter modification; thus, it deals with only the letter design. It is anticipated that this approach will provide students with a framework to focus their projects on letter modification, which is crucial for thriving in an industry marked by fierce competition (Sari and Prada, 2020). Notably, advancements in digital typography technology now enable individuals nostalgic for handmade arts/design products to seamlessly integrate both hand lettering and computer fonts (Turgut, 2014). According to Adkins (2013), best ideas start with pencil and paper when designing font by using CorelDraw. This prior author explored designing font with CorelDraw by first hand sketching the basic shapes that represent the American Captain font before scanning the image of the paperwork into the computer. The author attests that tweaking, adjusting, and testing of the letterform is exactly the kind of challenge that CorelDRAW is designed to handle. Eventually, the design can be exported from CorelDRAW as files that can be seamlessly imported into font editor. Present study is different from the prior authors because it fails to design font but only plays creatively with the letterforms for the purpose of boosting students' inspiration and familiarity with innovative letterforms. In other words, present study can also be considered as a creative process based on the declaration of Walia, (2019) that "creative process may or may not be successful in implementing ideas that solve problems, but attempts by potential creators may certainly bring these problems to the forefront for others to solve". Thus, present study presents an exploration of CAD inspiration for undergraduate students in the aspect of geometric modification in letter design for originality purposes. This can also provide avenue for the knowledge garnered in this study to be explored further by subsequent study.

Methodology

Research Method for Objective 1: Investigating challenges faced by students in letter design or related typographic work.

To address the first objective, a partially structured focus group discussion is employed. The interviews are conducted in four phases: planning, participant recruitment from undergraduate graphic design students, conducting interviews, data collection, and interpretation of obtained data.

Planning Phase: The aim is to explore the hurdles encountered by undergraduate students in letter design or related typographic work. For this purpose, third-year graphic design undergraduates are deemed suitable participants. An announcement soliciting voluntary participation in a letter design task is made to a class comprising 30 students. To ensure anonymity, the specific identity of the school and students remains undisclosed, as per the agreement with the participants and the institution.

Next, the investigation's questions and the focus group's principles (agenda, timing, location, audio recording) are presented to the participating students. The undergraduates opt to partake in the survey voluntarily to contribute their opinions and experiences. Two research assistants facilitate the interviews: one conducts the interview, while the other listens. The interviews are recorded using mobile phones and conducted in a distraction-free environment, typically an unoccupied design studio, to allow participants to focus uninterrupted on the academic process. On average, each interview lasts for 30 minutes.

Sample Description: Twenty out of the 30 students volunteer to participate in the study. Two focus group sessions are conducted within the anonymous design school premises. The participants' ages range from 18 to 22 years old. Table 1 provides further details regarding the sample composition.

Table 1: *Demographic data of participants*

Focus Group (FG)	Educational Qualification	Level	Number of Participants	Participants by Gender	
				Male	Female
FG1	Undergraduates	300 Level	10	7	3
FG2	Undergraduates	300 Level	10	5	5
Total			**20**	**12**	**8**

The execution and topics of the focus group interviews are carefully designed to facilitate open and descriptive discussions among participants. The questions are straightforward, avoiding simple yes or no answers, and encouraging participants to provide detailed responses. Participants are given the opportunity to express their opinions, experiences, and disagreements without interruption. The questions allow multiple responses, fostering a rich exchange of ideas. The interviews focus on various aspects related to letter design, including participants' motivations for participating in the study, their understanding of typographic design and letter design, prior experiences in these areas, knowledge of typography rules and guidelines, technical proficiency, technological barriers, and issues related to creativity, originality, copyright, and ethics. These topics are carefully selected to provide insights into the challenges and considerations involved in letter design.

Research Method for the second objective:
For objective 2, which involves geometric modification in letter design, it is essential to clarify that this study does not delve into the creation of new typefaces but rather focuses on experimenting with existing ones. The purpose is to increase students' familiarity with letterforms and prepare them for future careers in type design. To avoid legal issues related to copyright, the study utilizes letterform from open-source freeware fonts that permit non-commercial modification and adheres to 'fair use' permissions of the letterforms for educational purposes. Notably, this study uses only the outlines of the letterform for the modification and not the font files. CorelDraw is chosen as the software for the study due to its popularity and accessibility among students. While it may not be the industry standard for type design, it serves the educational purpose effectively. The term 'CAD' in this context refers to the use of computer application software to assist in the design process. CorelDraw, known for its simplicity and efficiency, is considered suitable for this purpose. Overall, the methodology ensures a systematic approach to investigating challenges and exploring geometric modifications in letter design while adhering to ethical and legal considerations.

In this study, geometric modification in letter design will encompass the utilization of both curved and straight lines within the letterforms. For letters originally composed of curved lines, a transformation will occur to integrate straight lines, ultimately resulting in octagonal letterforms. Conversely, for letterforms lacking curves, the introduction of additional angles and sides will occur. This method mirrors convenient sampling, ensuring a seamless experiment within the CAD software interface. Various techniques will be employed to modify the geometry of the letters, such as altering, removing, or adding nodes to different segments of the letters. The comprehension of letter anatomy, exemplified in the diagram within Figure 3, will serve as a crucial reference point throughout the process of geometric modification.

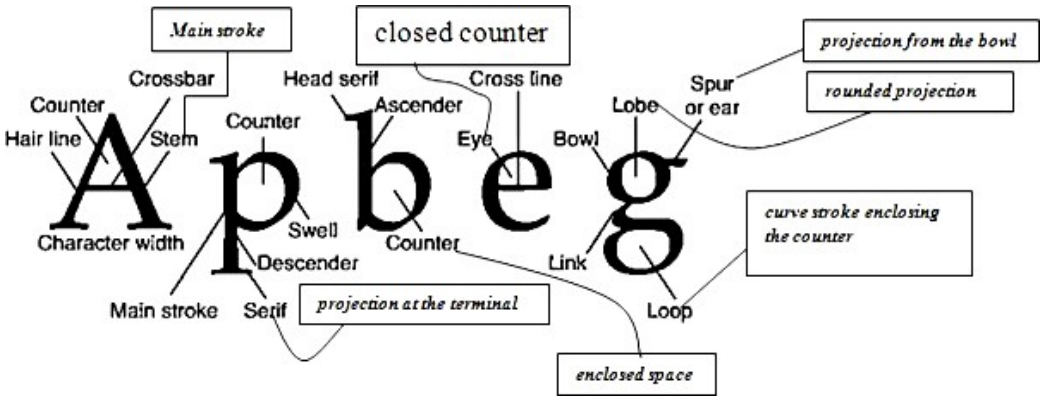

Figure 3: *Some considerable parts (anatomy) of letters during geometric modification*

Figure 4: *Uppercase and lowercase Geometr415 Blk BT in LibreCAD as well as beveled letter in CorelDraw*

By adeptly combining curved and straight lines and strategically adjusting the nodes within the letterforms, the study endeavors to showcase how geometric modifications can elevate the creation of new forms in letter designs. Display letters that can be used for headlines, outdoor advertising design and decoration are used (see Figure 4). Likewise, they are san serif letters of which one of them is an outline of the letterform from a beveled font and others are uppercase and lowercase geometric sans serif. The counter, crossbar, aperture, stem and eye can be modified by adding or removing the nodes, shapes and strokes. The lines, nodes, angles, and other parts shown in Figure 5 can be made editable through the use of CAD. 'Agency FB' designed by David Berlow for Font Bureau would have been used in the exercise but it is a commercial and copyrighted design that cannot be changed by others. The other option is to abide by the ‘fair use’ permission since it is an educational project.

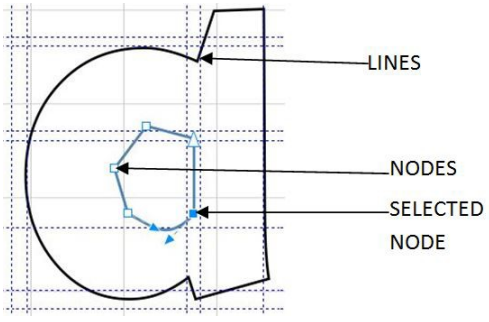

Figure 5: *Nodes of the editable outline*

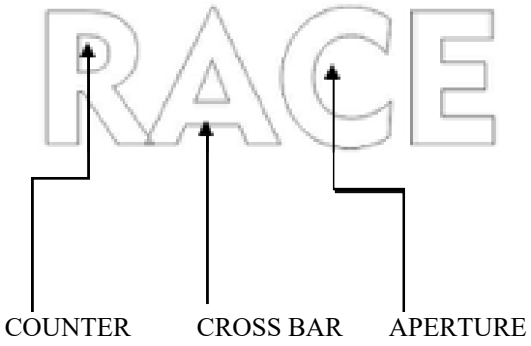

Figure 6: *Parts of letters to be modified in the already existing typeface (non-commercial modification/fair* use)

It is worthy of note that other software such as Microsoft Office Word, Adobe illustrator CS 6, Adobe Photoshop CS 6, Adobe Photoshop CS 5, and LibreCAD 7.5 are also examined to find suitable typeface for the exercise. The outcome results to using open-source freeware typeface that permit non-commercial modification (see Figure 6).

For instance, all fonts in LibreCAD are freely available without any compulsory permission from the inventor while for typefaces in CorelDraw, permission is sought from Bitstream Inc These typefaces allow further use in logo design and poster design to mention a few. On the safer side, present study is perfectly under fair use because it is strictly for educational purpose and not related to usage outside the designers' specification (Aufderheide et al., 2011; Althubiani, 2023; LibreOffice 2018; ETalks.23927486htvk, 2022; Corel, 2024: Netaniel, 2011; LibreCAD, 2018).

During the process of letter modification within the CAD interface, geometric modification of letters through the use of existing typeface and modification independent of existing typeface are compared by the use of the rating scale of 5 to 1(representing 'most significant' (5) to 'not significant' (1) in Table 2). Table 2 outlines the semantic differential scale (SDS) employed to gauge perceptions of inspiration during the design process. SDS is a measurement process for rating based on a series of bipolar adjectives scales separated by a fixed number of intervals (Yusoff et al., 2013). Eventually, this generates data in terms of mean score of the significance of the inspiring variables towards achieving graphic appeal of the modified new form. For instance, situation whereby the modification fails to reveal possibilities of salient modification scores 1 (not significant) while when there is very fantastic salient modification scores 5 (most significant).

Table 2: *SDS for the significance of the CAD inspiration for the letter modification*

Rating Scale	*Level to which the variables are significant*
1	Not Significant (NS)
2	Least Significant (LS)
3	Somehow Significant(SS)
4	Significant (S)
5	Most significant (MS)

The scoring is done simultaneously during the creative process. Specifically, bar chart, descriptive statistics and independent sample T-test are used for the analysis of CAD inspiration for the letter modification. To do this IBM SPSS (Statistical Package for the Social Sciences) Statistics 23 version is used. This software helps in the calculation of the descriptive statistics and independent sample T-test as well as generation of bar chart. T-test is used for comparing mean of two groups (i.e. comparing the typical occurrence of the variables between only two groups). Thus, an independent sample T-test is carried out for the two groups; namely, the category reliant on existing typefaces and the category independent of existing typefaces.

In this study, descriptive statistics includes mean (M) and standard deviation (SD) (see appendix A/B) as generated by using IBM SPSS statistics 23. The aforementioned analysis is necessary so as to show how the inspiration takes place during the modification process. Thus, showcasing the crucial role of CAD inspiration during the modification process. M represents the most typical occurrence of variables relating to CAD inspiration during the letter modification process. SD is the spread of the data in terms of proximity to the most typical occurrence. Low SD shows that the data are clustered tightly around the mean while high SD shows that the data are more spread out. Thus, low SD are more reliable and consistent compare to high SD when considering most typical occurrence of the data in this case.

Research Method for Objective 3: procedures that can encourage apathetic students to becoming motivated or inspired to seek originality in design project particularly in letter design

The methodology for Objective 3 is descriptive-based and incorporates intuition, literature review, and observation. Although this study focuses on design students in regions lacking adequate digital resources, it assumes a strong interest in CAD despite the digital deficiency. For instance, in such regions, a student might more truthfully attribute their failure in a design course to the lack of sketches rather than the absence of a personal computer. The point is that in these regions, sketching and manual design production should take precedence over CAD due to limited digital resources. Therefore, this study views CAD as a source of inspiration rather than a tool for the final production of designs. Just as inspiration can be drawn from nature, experiences, or the works of other students or designers, experimenting with CAD can also spark creativity. This is one of the rationales behind this study.

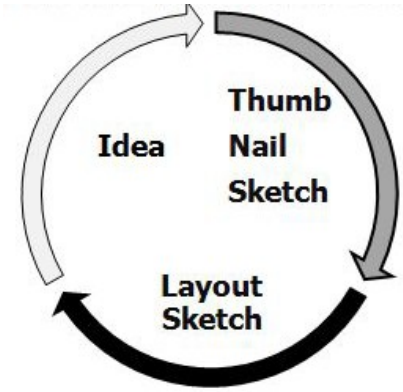

Figure 7: *Cycle of generating idea for a design project*

Brown (2009) observed that students seem to have lost fundamental skills because they prioritize CAD over actual academic training. Sketching, for example, is a crucial skill that students should develop as it allows for the quick presentation of conceptual prototypes. This can help students generate multiple ideas swiftly, fostering originality and creativity. According to Brown (2009), the knowledge students gain from their education should guide the appropriate use of technology. This means academic activities should take precedence over the heightened focus on CAD. Brown (2009) argues that students are becoming detached from their fundamental skills, their approach to design, and their understanding of how technology should be used in their training. Ryan (2008) consider sketching as a very important procedure that help in creating ideas towards originality. In figure 7, thumbnail sketch follows after idea and they are small roughly drawn visuals created in rapid succession (Ryan, 2008). This means idea generation and sketching are very important in a design project; especially, when seeking originality and creativity. Through thumbnail, the students will embark on the journey of turning the abstract vision into a working representation of their final idea (Brown, 2009). *According to Linus Pauling, "the best way to get a good idea, is to get a lot of ideas"* (Kelley, 2002, p. 55).

This will be a conceptual way of visualizing their idea through the cycle in Figure 7. Thus, a student might need to create many sketches to generate new ideas. Hand lettering is an interesting aspect of graphic design just like basic drawings (such as still life, landscape, and figure drawing to mention a few) are intriguing aspect of fine arts. The ability to communicate ideas through simple sketching was, and still is, a vital tool for designers (Brown, 2009). Thus, this study builds on this body of knowledge and other methods earlier stated to achieve the third objective.

Research Method for Objective 4: The efficacy of the suggested procedures.

Students are giving the freedom of using whatever tool, procedure or experiment that please them for their creative exercise and to transform letterform to any form they like. This is done to avoid interference with the possible outcome of the intervention and to see if students will work accordingly or otherwise.

Table 3: *Some of the criteria to be considered in relation to suggested procedures*

Criteria	Description
Interest	The level of interest of the student
Understanding	The level of understanding of the student
Motivation	The level of Motivation of the student :how curious /dedicated or attentive are they?
Appropriateness	The level of appropriateness of the design outcome
Originality	The level of originality, novelty or uniqueness
Instruction Interpretation	Minimized Communication barrier/bridge between the student and instructor
Intuition	Level of independence and Self expression
Flexibility	The ability to easily adopt and manipulate new idea without difficulty

Also, to avoid interference with their preference or interest. However, they are limited to English language. Accordingly, the students' interest, understanding, motivation, appropriateness, originality, feedback interpretation of instruction, intuition, and flexibility are analyzed in relation to the suggested procedures (see Table 3) by using Likert scale for rating the criteria.

As a result of the suggested procedure expected to encourage apathetic students in design, it is hoped that the level of interest of the students can be rated on the scale of 5 to 1 (see Table 4 and appendix A/B for more clarity). In Table 4, VID =1, stands for very indifferent; ID = 2 stands for indifferent; N = 3, stands for neutral; I= 4, stands for interesting; and VI = 5, stands for very interesting. The corresponding values are used for rating the level of interest of the students as they go through the suggested procedures. .NU =1, stands for not understandable; AU = 2 stands for indifferent; N = 3, stands for neutral; I = 4, stands for interesting; and VI = 5, stands for very interesting. The corresponding values are used for rating the level of understanding of the students as they go through the suggested procedures.

In table 4, VLM =1, stands for very low motivation; LM = 2 stands for low motivation; MW = 3, stands for moderate motivation; HM = 4, stands for high motivation; and VHM = 5, stands for very high motivation. The corresponding values are used for rating the level of understanding of the students as they go through the suggested procedures. For instruction interpretation, flexibility, and intuition, VL =1, stands for very low; L = 2 stands for low; M = 3, stands for moderate; H= 4, stands for high; and VH = 5, stands for very high. For rating the level of originality, novelty or uniqueness as well as the level of appropriateness of the design outcome, NS =1, stands for not significant; LS = 2 stands for least significant; SS = 3, stands for somehow significant; S = 4, stands for significant; and MS = 5, stands for most significant (see appendix A/B).

Also, method/tools used, rate of CAD usage, fundamental design principles, and number of sketches are analyzed. Some of the aforementioned parameters are analyzed by using bar chart and frequency table. Chi- square tests also used for originality of paperwork produced in relation to how the participants used CAD. One way ANOVA (analysis of variance) and independent sample T-test are also used. "One-way" as used for ANOVA means that it specifically about the suggested procedures (i.e. only most typical of its effective occurrence will be compared). ANOVA is a statistical technique that is used to check the effectiveness of the suggested procedures by comparing the means of the different procedures based on how the students used them. Based on how the students freely adhered without been compelled, ANOVA can be used to prove or disprove if the suggested procedures are effective or not. The reason is because it not

Table 4: *Likert scale for some of the criteria to be considered in relation to suggested procedures*

Scale	*Interest*	*Understanding*	*Motivation*	*Intuition*	*Flexibility*	*Originality*	*Appropriateness*
1	VID	NU	VLM	VL	VL	NS	NS
2	ID	AU	LM	L	L	LS	LS
3	N	N	MM	M	M	SS	SS
4	I	U	HM	H	H	S	S
5	VI	VU	VHM	VH	VH	MS	MS

easy to just conclude by mere observation or comparison; thus, one way ANOVA is considered suitable for this analysis. Normally, there is null hypothesis and alternate hypothesis when using T-test or ANOVA. The null hypothesis can be considered as follows:

(i) there is no difference among the means of the suggested procedures. This means there is no difference in the most typical occurrence of the suggested procedures.
(ii) the suggested procedure is not effective
(iii) variability between groups is not larger than variability within each group.

The mean of the "between groups" divided by the "within group" is equal to the F-value. The probability value is the p-value. It is the number describing how likely that the occurrence is under null hypothesis or not. F- value greater than p-value, is significant .i.e. effective. In such situation, the evidence is strong to reject the null hypothesis in favour of the alternate hypothesis (.i.e. the suggested procedure is effective). When the null hypothesis is "the suggested procedure is not effective", then p-value is less than/or equal to α (.i.e. 0.05).

Result and Discussion

Result for objective 1: Challenges facing students in letter design or typographic design work

Group Interview Findings

Twenty (20) out of thirty (30) actually volunteered to participant in this study. Three (3) out of twenty (20) participants decided to participate because they hope to benefit from the study. The remaining 17 participants are silent and give no response. "*As a person having ADHD, lettering is an interesting aspect of graphic design that captures my attention and helps me to concentrate*" (male, no.15). ADHD is attention deficit/hyperactivity disorder. (This seems similar to prior study that examine font size and type in relation to enhancing the attention span of children living with ADHD (Phalke et al., 2023)). "*I think I will learn something new*" (female, no.10). "*Every topic in graphics is important to me; so, I want to know any aspect of graphic design*" (male, no.20). The observation is that few students see the need for adequate attention to this aspect of art and design. Analysis of the interview shows that none of the participants have challenges of understanding the meaning of letter design or typographic design works. All of them consider typography to be related to text seen on the digital screens like phones and computer as well as the textbooks. "*I think typographic design work and letter design are the same because both can be used for logo design*" (male, no.1). "*I think typography and lettering should be considered as one*" (male, no.6). Majority of them think that only typography should be taught in the University because lettering is elementary. "*I think hand can be easily used for lettering since it is just drawing of letters but it will be very tedious to use hand for type design*" (female, no.12). "*I think letter design is more related to display category of letters while typography is more relevant to the textbooks, mobile phone and computer*" (male, no.18). "*Typography is not the same as lettering; 'lettering is different from calligraphy even though both are considered as one because of the use of hand*" (female, no.20).

All the participants have done the design and art of lettering in their previous works; But, only fifty percentages (50%) of the students have done design works related to typography. "*I have done courses in lettering and typography; in lettering, we drew letters while, we used computer for logo design, typing, book design, advertising design, and publicity design*" (female, no.12). "*I did letter construction in primary school, secondary school and university*" (female, no.20). Majority do not know the rules and guidelines in typography. They do not mention any anatomy of letters or terms such as kerning, leading and other terms in typography. "*I don't know any typographic rules and guidelines*"(male, no.15). Majority of them have not attempted the use of CAD for letter modification and many of them use mobile phones for their typographic design work. "*I don't know how to use computer application for letter design but I have used CorelDraw for my other designs such as advertising design and others*" (female. no.12). "*For logo design, I used the computer fonts*" (male, no.2). "*Most logo designs I did were*

directly from mobile app such as Canva and I never like to draw logo with hand" (male, no.5). Many of them do not like to sketch their idea but prefer to use computer for their designs. Majority experienced technical limitation in terms of electrical poor supply, lack of computer and other accessories. *"...for example, I decided to use mobile phone for graphic design because, I don't have a computer*" (male, no.5). "*we know that there are a lot to learn from the internet but we face a lot of limitation concerning internet connectivity* (female, no.4)" "*It is very painful that we don't have access to computer programs that can help us in our design works*" (female. no.9). "*We cannot buy computer application programs from the internet because they are very expensive* " (female, no12) "*...Our instructors use old version of computer programs such as CorelDraw and other common programs such Adobe Photoshop* (male, no.19)" "*both students and instructors are affected by technological barriers* (male, no.7)" "*we have access to some trial version of latest computer programs and freeware are not common*"(male, no.8). "*I don't like using hand for design and I like to do my designs with computer* " (female, no.14).

Result for Objective 2: Geometric modification in letter design

a. Abiding by Fair Use of Existing Typeface for the Geometric Modification:

The outlines of the letters are set to hairline and broken apart so that individual letters can be modified (see Figure 8a). The removal of nodes have enabled some curve lines and planes to have been eliminated. The use of grid lines help in checking the proportion of the section of the letters (see Figure 8a and 8b). This also aid the alignment of the design elements, as well as the proportionate and appropriate adding of nodes to the lines at the eye, aperture, stem, counter and other parts, so as to create more angles when moved or repositioned.

In Figure 8a, some of the straight and perpendicular lines to the angles have been transformed to diagonal lines. The 90 degree angular edges and sides of some of the stem and other strokes have been modified to polygonal sides. In letter 'R', first perpendicular lines are not modified except at the counter. The perpendicular lines and 90 degree at the corners within the aperture of letter 'C' is also modified but that of letter 'E' remains perpendicular. (see Figure 8a). At the stem of letter 'E', the point

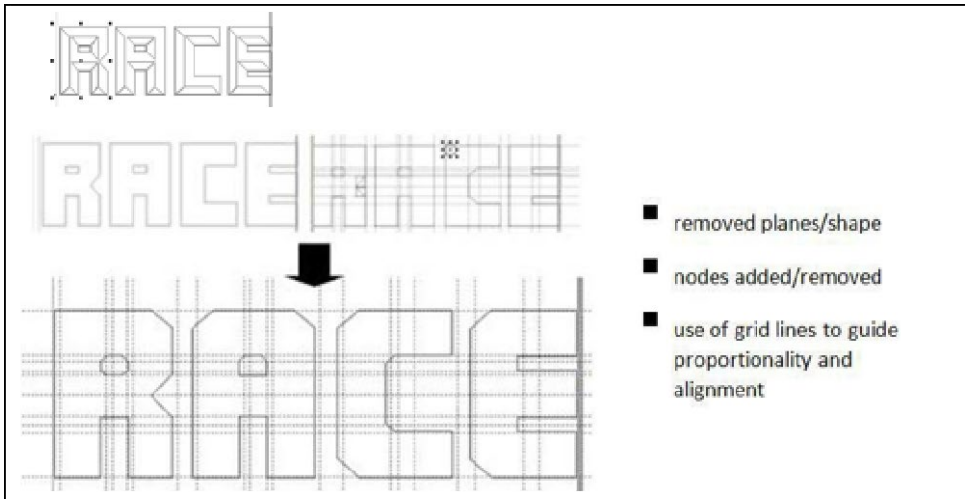

Figure 8a: *Broken apart artistic text and geometric modification of some perpendicular angles as well as lines to derive octagonal letterform*

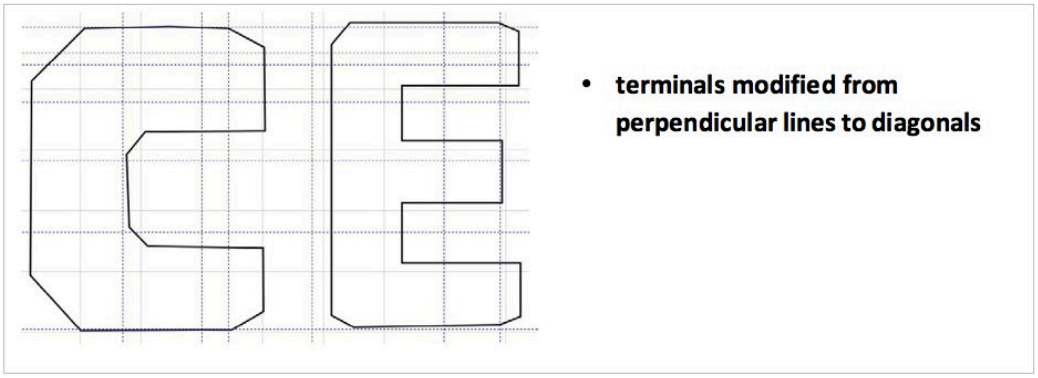

Figure 8b: *Geometric modification of perpendicular lines at the terminal of the letters*

where the lines suppose to intersect at 90 degree is modified to diagonal lines. This illustrates geometric modification of straight strokes in the letters to diagonal lines of the octagonal letterform. The terminals of the letters can be further transformed from perpendicular corners to diagonal by adding nodes and repositioning or moving them (see Figure 8b). The typeface in figure 8a is different from figure 9a. While beveled, angular and quadrilateral letters are modified in Figure 8a, figure 9a consist of triangles (e.g. letter 'A') and circular letterform (letter 'C'). This necessitate kerning while transforming circular letterform to octagonal because negative space will increase after changing the bowl of the circular letterform (.i.e. letter C) to a stem (see Figure 9a and 9b). Even, the triangular letterform when modified to quadrilateral or octagonal will require letter spacing because of the tight closeness that will exist as a result of the extension of the added nodes to the line segment (see Figure 9b).

In the process of modifying a particular letter , different letterform emerges (for example, in the case of the letter 'A' before the last arrow in Figure 9b). This kind of situation can be inspiring and further possible appearance or structures can be done. Thus, in the process of letter modification one can be inspired and a particular idea can be further explored or improved. Having derived the uppercase, the next illustration involves the geometric modification of a lowercase. For the lowercase in Figure 10a and Figure 9b, the edges of the letters consist of straight stroke of the stem (letters 'a' and 'r) and the curve lines (at the bowl, counter and aperture). The letters are

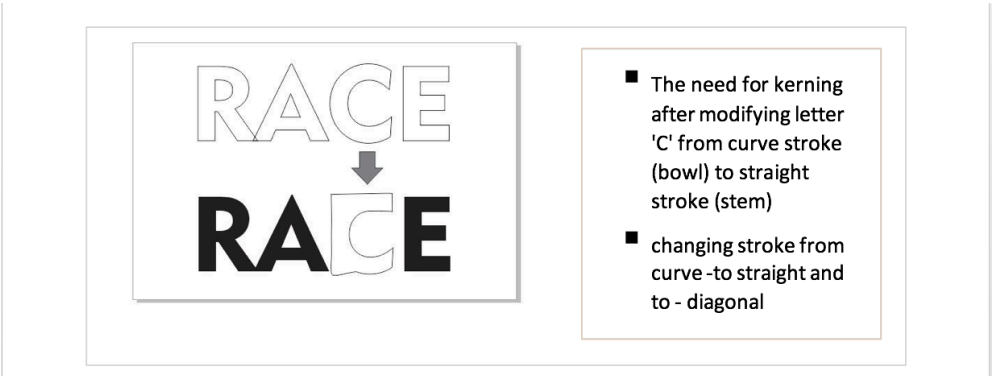

Figure 9a: *Geometric modification of curve lines in circular letterform (letter 'C')*

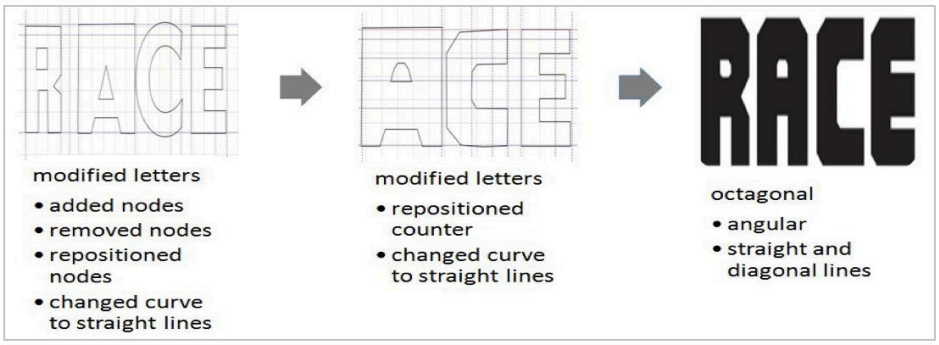

Figure 9b: *Geometric modification of triangular, curve and perpendicular lines to derive octagonal letterform*

broken apart and grid lines are also included so that each curve corner can be modified to angular corner. Each letter is converted by increasing the nodes of the editable line segments in the curve. This enables the inclusion of more angles and to enables the curve segments of the letters to be converted to straight lines. The cell of the gridlines also guide the proportion of the letters. The extension of line segment closes the letter spaces, thus; there is need for kerning as a result of the extension (see Figure 9b).

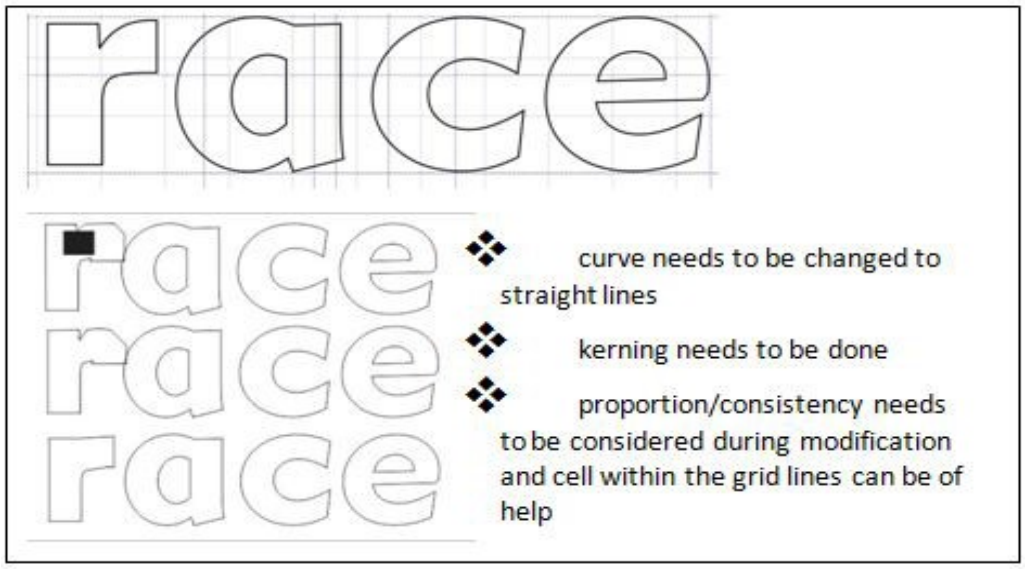

Figure 10a: *Geometric modification of curve lines in lowercase to derive octagonal letterform*

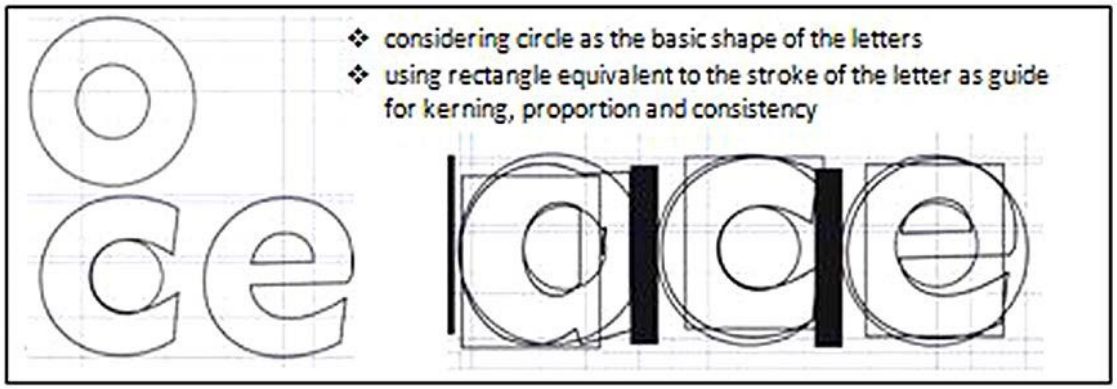

Figure 10b: *Curve lines and the circular letterform of the lowercase*

The lowercase letter 'a' in Figure 10a is a single story. To transform the single story letter 'a' to a double story will require addition of nodes, extension, reposition and moving of the line segment (see Figure 11a). The curve corners are also transformed to diagonals to form octagonal. Thus, the counter, aperture, strokes, stem, and flat foot or tail of the lowercase letter have been the parts of the letters that are modified. It can be observed that the original letter 'a' in figure 10a is single story and does not have a flat foot or prominent tail but through geometric modification it is now modified (see Figure 11a). This also differentiate the modified letter from the original letter (see Figure 10a, 11a and 11b).

b. Geometric Modification in Letter design without depending on Copyrighted Typeface:

With the use of grid lines and cells of 3 by 5, a rectangle of size 0.494" X 1.26" is used as the stem of the letters in CorelDraw so as to design octagonal letter without infringing the copyright of any established typeface.

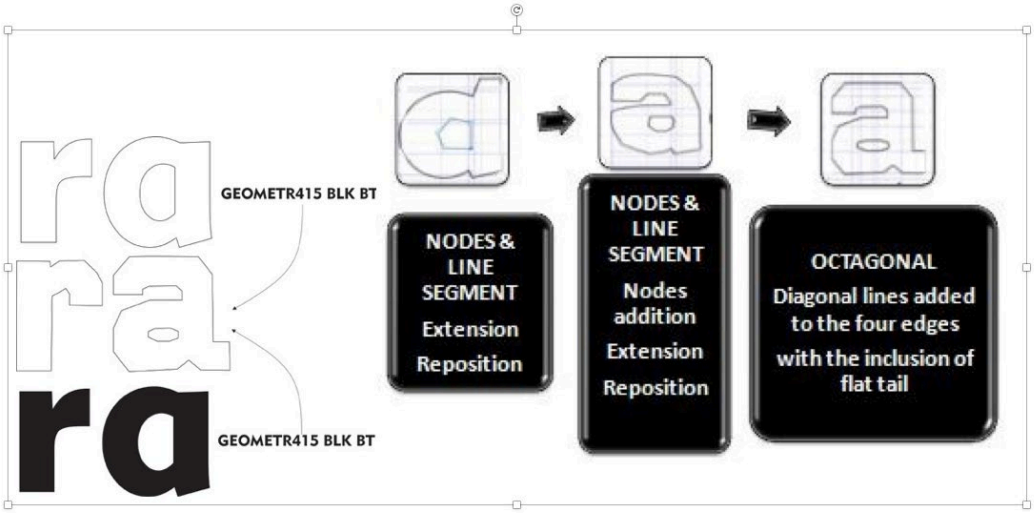

Figure 11a: *Transforming of curve lines in a single story letter 'a' to double story 'a'*

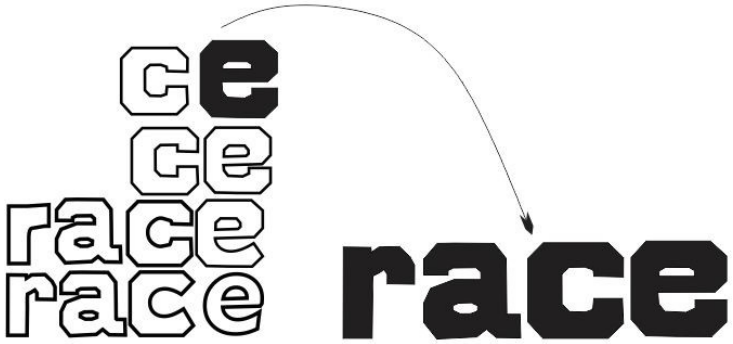

Figure 11b: *Geometric modification of curve lines and edges to diagonal to form octagonal letters*

Although, typeface designs themselves are not eligible for copyright protection. This means that the artistic concepts and shapes of letters in a typeface are generally not protected by copyright law in most jurisdictions (Althubiani, 2023). This rectangle is adjusted to fit 3 by 5 cells at the height and width of each letters. respectively. To obtain a letterform, two or more rectangular shapes (.i.e. stems) are combined by welding (see Figure 12). Display and decorative letters for outdoor spaces and editorial or publication design can be independently created without the use of licensed typefaces by following the process illustrated in Figures 12, 13a and 13b. This digital method of constructing letters involves several key steps. After the combination of necessary shapes, it is welding follows. Then, nodes are repositioned or moved to achieve the desired shape for the letter. Additionally, more nodes can be added, letter spacing adjusted, and shapes incorporated (see Figure 13a). For example, the aperture of the lowercase letter 'c' is deliberately made rectangular, showcasing the freedom afforded by not relying on existing typefaces. This reflects flexibility while not relying on the modification of existing typeface. To enhance the visibility of the tail in the lowercase letter 'a', additional nodes are incorporated and repositioned (see Figure 13 a). Grid lines are also used to ensure consistency and proportion. Similarly, the lowercase letter

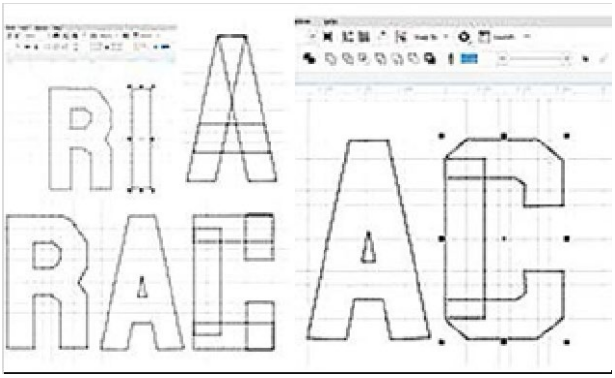

Figure 12: *Geometric modification of rectangular shape to derive octagonal letterform*

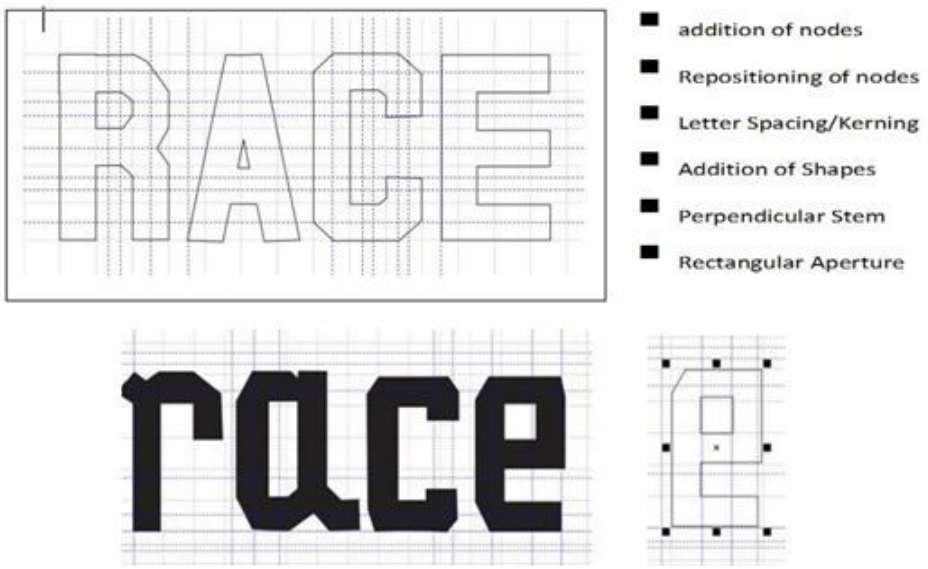

Figure 13a: *Geometric Modification of rectangular shape to derive octagonal letterform for both lowercase and uppercase*

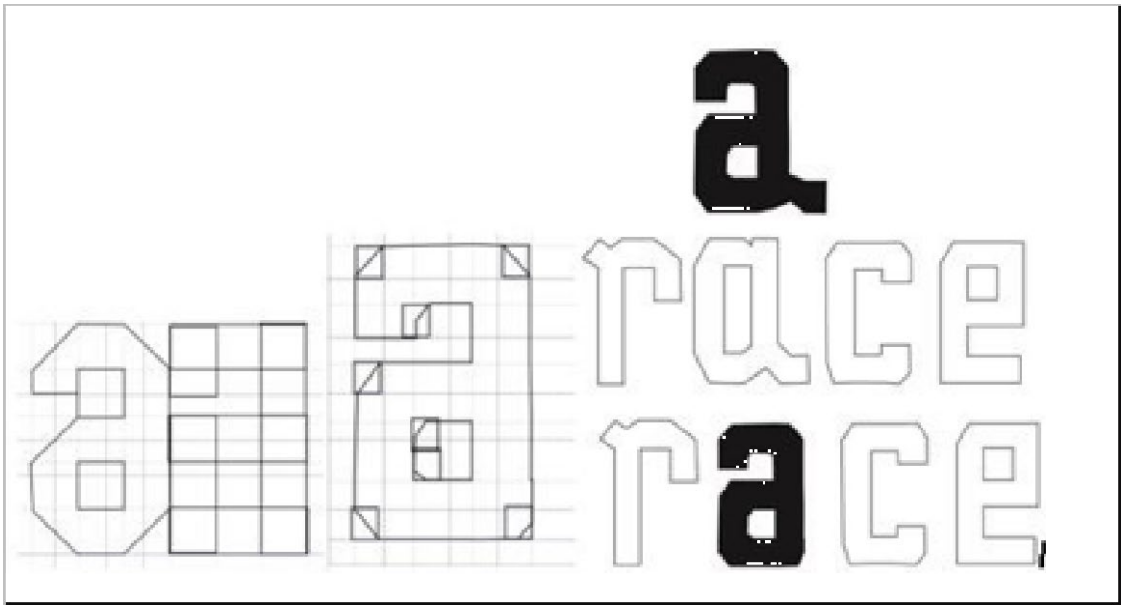

Figure 13b: *Geometric modification of rectangular shape to derive double story lowercase letter 'a' for octagonal letterform*

'e' is transformed from a rectangular appearance by adding and repositioning nodes, modifying the perpendicular lines into diagonal lines, resulting in an octagonal form (see Figure 13a).

Making the lowercase 'a' to be a double story letter also require combination of rectangles, welding and modification of angles and perpendicular lines as seen in Figure 13b. Some rectangles are arranged to form the basic structure of the letter. This involves precise alignment and positioning to ensure the correct proportions and overall shape. Welding these shapes together is the next step, which fuses the rectangles into a cohesive form.

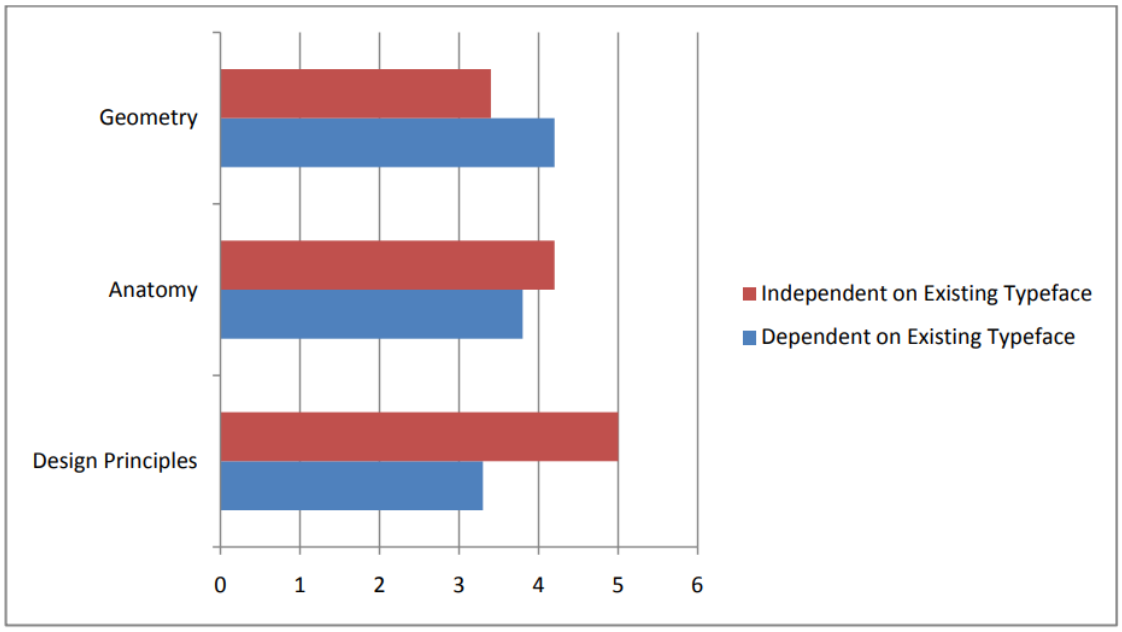

Figure 14: *geometric modification of letters in relation to the level of CAD inspiration*

After welding the shapes together, some points where lines intersect at 90 degrees are adjusted to form diagonal lines This alteration enhances the aesthetic and structure of the letter. Furthermore, the use of grid lines plays a crucial role throughout this process. The grid provides a reference for maintaining proportion and consistency, ensuring that each component of the letter is correctly sized and positioned. Figure 13b illustrates these steps in detail, showcasing the transformation of the lowercase 'a' into a double-story character with the aid of geometric precision and careful modifications.

Figure 14 presents a bar chart comparing two categories: the use of existing typefaces and original designs created without copyrighted typefaces during the geometric modification of letters. modification process. As shown in Table 5, CAD inspiration has a significant impact on adherence to design principles, with a mean score of 3.3 for existing typefaces and 5.0 for original designs created without copyrighted typefaces during geometric modification. This influence is particularly pronounced when working with the anatomical features of letters and executing geometric adjustments within the CAD interface. The CAD environment enables precise modifications while fostering intuitive creativity among designer and students during the design process.

Table 5: *Level of CAD inspiring variables in relation to the letter modification process*

Design Principles	Dependent on Existing Typeface	Independent on Existing Typeface
Alignment	3	5
Proportion	3	5
Unity/ Consistency	3	5
Spacing/Kerning	3	5

Proximity	3	5
Balance	5	5
Mean	**3.3**	**5**
Anatomy		
Aperture	5	5
stem	3	5
Counter	3	3
Crossbar	5	5
Eye	3	3
Mean	**3.8**	**4.2**
Geometry		
grid lines	5	5
Convert to Curve	5	0
Nodes	5	5
Shapes	3	5
Cells	3	5
Repositioning	5	4
Perpendicular	5	5
Lines	5	5
Angles	5	5
Sides	5	3
condensing shape	3	0
Elongating shape	3	0
Mean	**4.3**	**3.5**

In the aspect of geometry, an independent sample T-test revealed no significant difference (t(1.2), p = 0.243, α =0.05) between the category reliant on existing typefaces (M = 4.3, SD = 0.9847) and the category independent of existing typefaces (M = 3.5, SD = 2.1950). This suggests that both categories exhibit similar relationships between CAD inspiration and geometry. Notably, CAD inspiration played a crucial role in the geometric modification process for both categories, but its impact is more consistent in the category dependent on existing typefaces, where numerous adjustments using convert to curve, addition or removal of nodes and other geometric adjustments are used to transform the original typeface into a new letterform. Design principles are considered more significant for geometric modifications independent of existing typefaces than for those dependent on existing typefaces (see figure 14). The inferential statistics using an independent sample T-test shows that the category dependent on existing typefaces (M = 3.3; SD = 0.82) and the category independent of existing typefaces (M = 5.0; SD = 0.00) have a significant difference (t(-5), p = 0.01, which is less than the significance level α = 0.05). Therefore, we can conclude that the mean scores for the two categories are significantly different regarding how CAD inspiration relates to design principles. With a mean score of 5.0 for the category independent of existing typefaces, CAD inspiration played a crucial role in emphasizing design principles during the modification process. This is because designing

from scratch requires careful attention to each part of the letterform, making adherence to design principles very important. In contrast, for the category dependent on existing typefaces, the original design already incorporates alignment, proportion, unity, consistency, proper spacing or kerning, proximity, and balance. Thus, CAD inspiration has less impact on design principles in this case, as the original typeface designer has already applied these principles to the type design. The inferential statistics using an independent sample T-test show that the category dependent on existing typefaces (M = 3.8; SD = 1.0954) and the category independent of existing typefaces (M = 4.2; SD = 1.0954) have no significant difference (t(-0.577), p = 0.580, which is more than the significance level α = 0.05). Therefore, we can conclude that the mean scores for the two categories are not different regarding how CAD inspiration relates to design principles. The crux of the matter is that CAD inspiration played a crucial role in emphasizing anatomy in similar pattern during the modification process for both category dependent on existing typefaces and category independent of existing typefaces. This affirms the importance of the knowledge of anatomic features which this study intents to achieve in the aspect of encouraging originality that can happen when the students are familiar with structures of the letterform in every possibilities of unique appearance.

Result for Objective 3: procedures that can encourage apathetic students to becoming motivated or inspired to seek originality in design project such as letter design

Figure 15a, 15b and 15c show the procedure suggested to encourage indifferent students to becoming motivated or inspired to seek originality in design project such as letter design. Design students are encouraged to incorporate the use of design brief, mentorship and sketching while generating idea for their creative letter design. It is hoped that students' adoption of mentorship will enable them to get better ideas for their project and it is expected this should be interesting to them.. Also, sketching is not a new practice in design. They should brainstorm for ides through sketching. For easy communication, both instructor and the students can present design brief. For example, if the instructor has presented design brief for a particular assignment, the students can present design brief for the execution of the given assignment about how he or she intends

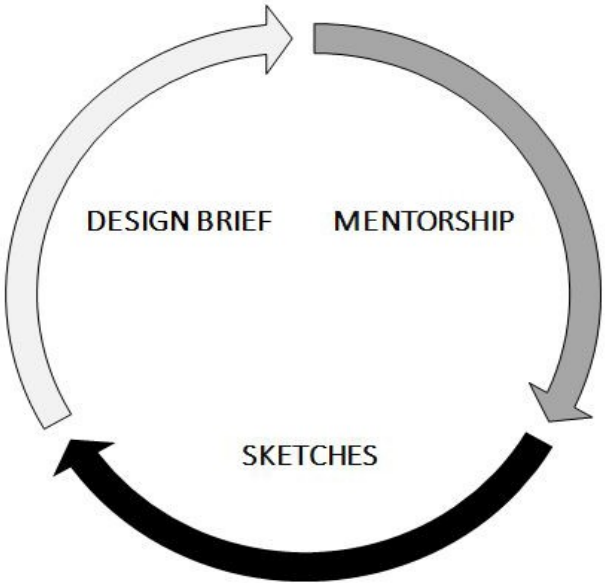

Figure 15a: *Suggested ways of generating initial idea for the letter design before proceeding to CAD*

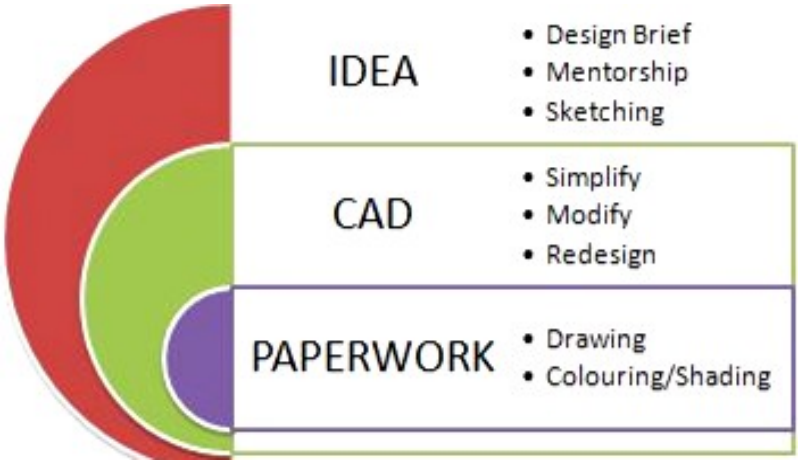

Figure 15b: *activities that students can inculcate during the letter design class exercise*

to approach the assignment. Then through, mentorship, such students can be guided. Based on TBA (Theory of Planned Behaviour), it is expected that students' compliance with these procedures may encourage them to be more creative, original and innovative during the design project. According to TBA, the interest of the students, typical norms or practice, and the perception of the students to identify what is best for them can influence them to perform a target behaviour in the appropriate way. The more positive the students' attitude, subjective norms and PBC (perceived behavioural control), the greater their behavioural intention (Guo et al., 2023).

Figure 15a is a cycle of process that is expected during the attempt to finalize idea for the design project before further inspiration through the use of CAD. After the students have drafted the design brief, it is expected to be accompanied with some preliminary sketches. These two should be shown to the mentor for guidance. After the contribution of the mentor, further sketches can be done for better idea before proceeding to the use CAD.

But, at this point CAD should be considered as means of inspiration to imagine the design either according to already conceived idea or outstandingly new idea better than what is already planned. That is the reason for either modification, simplification or redesigning (see Figure 15b). CAD is still a remarkable tool which can be harnessed correctly by using both hand lettering and computer fonts together (Turgut, 2014).Thus, it is the assumption of present study to inspire design students by suggesting the aforementioned procedures and also explore geometric modification of letters by using CAD.

CAD is not expected to be the ultimate in this process. It should be like a 'middle-man' and made penultimate in the creative process (see Figure 15c). It is expected that the use of CAD should inspire the students towards producing creative paper work for the letter design. Perhaps, various ways of visualizing the design beyond what the mind has initially conceived can occur within the CAD environment. Though it might seem playful, a student is expected to see other different interesting ways of doing their design works. This is referred to as CAD inspiration in this study. CAD is the

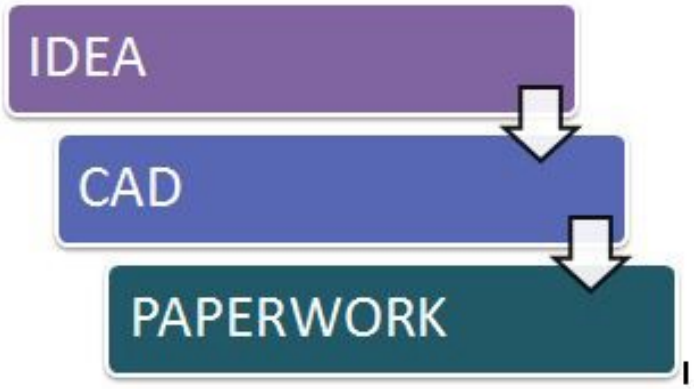

Figure 15c: *The position of CAD for source of inspiration towards producing paperwork for the letter design*

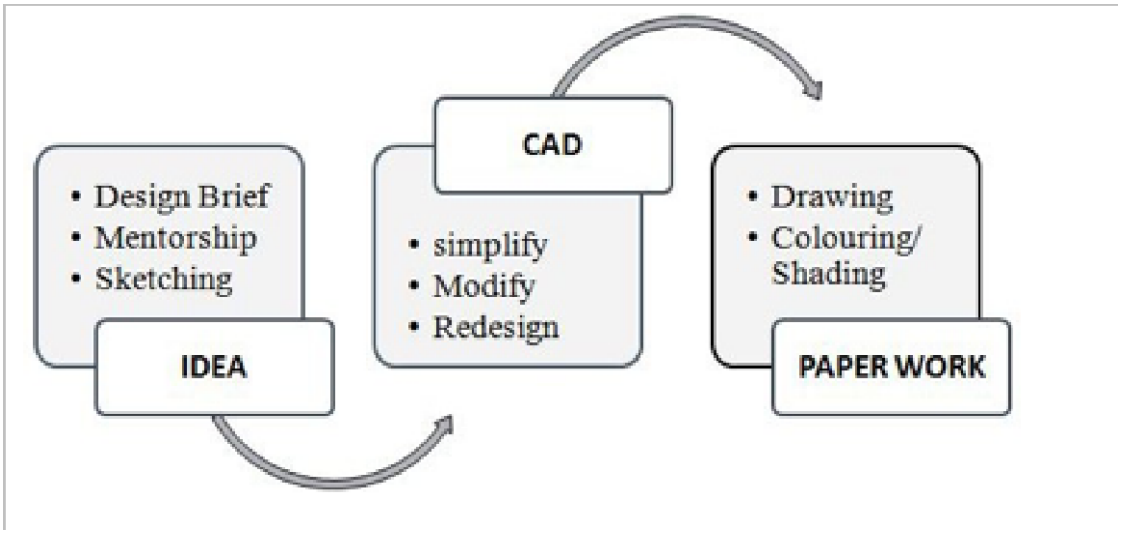

Figure 16: *Procedures that can encourage student's originality through penultimate use of CAD*

penultimate in this process as seen in Figure 15c as well as in Figure 16. The ultimate is the paper work; so the students draw the letters, shade or paint the letters with the use of their drawing sets. This is to moderate the use of CAD as source of inspiration and not to be over dependent on CAD as the final production of their project.

Their idea from the sketches can be further adjusted, simplified or redesigned through the use of CAD and finally, the manual production of the letters are drawn on paper. The notion of this study is that students should find it interesting to explore this modification by both drawing on paper and as well as making use of CAD.

Design brief involves describing the intended path to the outcome of the design (Read & Bohemia, 2012). Thus, if students should draft design brief for their project in letter design, instructors will clearly decipher their intention. This can create room for better feedback interpretation of instruction during typography and lettering class. It can minimize the limitation that may occur in the communication route between the students and instructor. Moreover, the students will understand their works better. Phillips (2004) defines a design brief as '… a written description of a project that requires some form of design' (p. 1), containing project overview, its objectives, tasks, timeframes and outcome expectations (Sadowska et al., 2017). It is an early description

of the design problem and the possible description of the solution or strategies that can be used to solve such design problems (Philips, 2004; Read and Bohemia, 2012). One of the function of a brief is to inspire new and innovative ideas; thus, design brief will enable the success of innovative activities (Read & Bohemia, 2012). Many a times, what may be included in a design can include: project goals, aims and objectives, background research, future aspiration, target audience, process or stages, deadlines or time-frame, performance measures/evaluation and project deliverables. It is worthy of note that the drafting of design brief for design project will guide them to achieving innovative designs. So, participants in this study are encouraged to draft design brief for their project. They are instructed to indicate whether they need mentorship/guide for more knowledge and refinement of their idea. Accordingly, the students are encouraged to communicate their idea through the use of design brief as well as producing sketches before proceeding to the use of CAD (see Figure 16, 15a and 15b).

Result for Objective 4: the efficacy of the suggested procedures:
The male participants demonstrated greater consistency in sketching, with a standard

Table 6: *Adoption of some of the suggested procedures according to gender.*

Group Statistics

Suggested Procedures	Gender	N	Mean (M)	Std. Deviation (SD)	Std. Error Mean
Sketching	Male	12	6.67	4.887	1.411
	Female	8	10.25	6.274	2.218
Design Brief	Male	12	1.08	.289	.083
	Female	8	1.13	.354	.125
Mentorship	Male	12	1.17	.389	.112
	Female	8	1.13	.354	.125
Rate of CAD Usage	Male	12	1.42	.793	.229
	Female	8	2.13	.641	.227

Table 7: *Adoption of design brief as a procedure*

		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No Design Brief	18	90.0	90.0	90.0
	There is Design Brief	2	10.0	10.0	100.0
	Total	**20**	**100.0**	**100.0**	

deviation of 4.887. However, some female participants (M = 10.25, SD = 6.274) engaged in more frequent sketching than their male counterparts (see Table 6, Figure 17 and appendix). The greater consistency among male participants may be attributed to their perception of sketching as easier or simpler. For instance, one female student refused to sketch, while some male students sketched only once. Notably, there is a female participant who generated ideas by creating 21 sketches (see appendix).

Table 7 shows the extent of adoption of design brief, 90% of the participants refuse to draft design brief while 10% of participants engage in the drafting of brief for the design project. The fact that few male (M = 1.08, SD = 0.289) and female (M =1.13, SD = 0.354) engage in the drafting of design brief may be because it is new to them and they need more time to get accustomed to it (see Table 7).

The need for mentorship is expected to help in generating ideas and with the collaboration of design brief and sketches, it is believed that instructors will be guided on mentoring a student better. If such students have cultivated the habit of doing these suggested procedures, it is expected that useful ideas and more original or creative works will be produced. Table 8 shows the extent of the adoption of mentorship as helpful procedure. 85 % of the participants fail to see the need for mentorship when seeking

Table 8: *Mentorship as a procedure*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No need of Mentorship	17	85.0	85.0	85.0
	Mentorship	3	15.0	15.0	100.0
	Total	**20**	**100.0**	**100.0**	

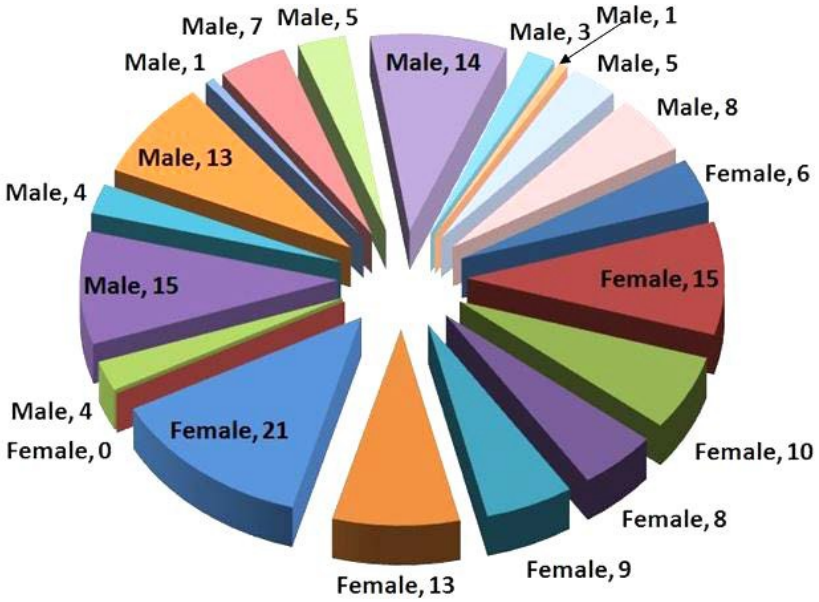

Figure 17: *Number of sketches done to generate ideas by both Male and Female Participants*

Table 9: *Originality of the paperwork produced in relation to how participants used CAD*

How the student used CAD * Originality Cross tabulation

Count

		Originality			
		Least Significant	Somehow Significant	Significant	**Total**
How the student used CAD	ultimately to Simplify	0	3	0	**3**
	ultimately to Simplify and modify	0	1	0	**1**
	utimately to simplify, modify and redesign	0	9	0	**9**
	Pen-ultimately to Simplify and Modify	1	5	1	**7**
Total		**1**	**18**	**1**	**20**

to accomplish a design project. Only three (3) which is just 15 % of the participants adopt the suggestion of seeking the contribution of a mentor when seeking for ideas for the letter design project. The fact that there are few male (M = 1.17, SD = 0.389) and female (M =1.13, SD = 0.354) ready to be mentored may be because they considered the task as an easy one or probably, some of them do not like to work under supervision.

Table 9 shows how the students used CAD towards achieving originality and reveals that 7 out of 20 used CAD in a penultimate way .i.e. they do not finalize their work based on works produced on the screen. They only use CAD as source of inspiration towards producing creative paper work for the letter design. Visualization of the design beyond what the mind has initially conceived within the CAD environment does not trash their sketches but it serves a continuation of the design process in a process of implementing ideas (Walia,2019). This creates room for further modification, simplification or redesigning. Having allowed the students to freely participate in the project without interfering with their creative activities, only 3 out of 20 ultimately used CAD to simplify the letterforms with somehow originality. Only one participate modify the letterform ultimately through the use of CAD. Also, the originality of the participant is somehow. Majority of the participants simplify and modify the letterforms by using CAD but they fail to use CAD as a 'middle-man'. They depend more on CAD and this is not the appropriate way expected. In Table 9, nine out of the twenty participants fall into this category. They also reflect somehow significant originality. Examples of their paper works are shown in Figure 18 and appendix C.

Majority of the students used CAD to ultimately simplify and modify the letters but their originality are mutual (.i.e. somehow questionable in terms of significance to the CAD inspiration) because of the similarity in their works. For reasons such as 'copy-cat' attitude, laziness, lack of need for mentorship, lack of need of doing several sketching, lack of design brief, lack of redesigning or re-modification, lack of need for originality and to mention a few can be assumed to be responsible for some of the works looking like exact replicas of one another. This is the reason for the somehow significant originality (.i.e. 18 out 20 have somehow significant originality). Very few have noticeable originality. Perhaps, none

Figure 18: *Examples of the student' paper works*

of them carryout redesigning which would have distinguished their originality when they discovered the mutualism in terms of similarly looking works.

Table 10 shows chi-square tests for originality of paperwork produced in relation to how the participants used CAD. Pearson chi-square value when positive as seen in table 10 signifies that there is some relationship between originality and the way participants used CAD. But, null hypothesis been that there is no significant relationship between the two variables means p-value is greater than α (0.05). In table 10, asymptotic significance (2-tailed) is 0.659. Thus, the way the participants used CAD in this study has no relationship with the paper work produced. The likelihood ratio (LR) shows how likely is the possibility of the originality in relation to how the participants used CAD. LR greater than 1 shows that there is possibility of the influence of how CAD is used towards fostering the originality of the paper work. LR value of 4.628 shows that there is possibility of producing paper works with very significant originality but due to lack of adherence to the suggested procedures makes it seems that there is no relationship between the

Table 10: *Chi-Square Tests for originality of paperwork produced in relation to how student used CAD*

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.127[a]	6	.659
Likelihood Ratio (LR)	4.628	6	.592
Linear-by-Linear Association	.000	1	1.000
N of Valid Cases	20		

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .05.

Table 11: *Rate of CAD usage*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	10	50.0	50.0	50.0
	Moderate	6	30.0	30.0	80.0
	Excessive	4	20.0	20.0	100.0
	Total	**20**	**100.0**	**100.0**	

way the participants used CAD and the paper work produced.

Since p>0.05 there is no sufficient evidence to conclude that the observed distribution is different from the expectation. The expectation is that CAD should be used pen-ultimately by simplifying, modifying and redesigning their initial idea before finally producing the paperwork. The low compliance of the students to the suggested procedure does not create room for originality. X2(df = 6, N = 20) = 4.127a, p = 0.659 shows that there is no association between the two variables (originality and the way the students used CAD). There are a lot of similarly looking design probably because they fail to adhere strictly to the suggested procedure. Some of the works are as if they are not modified at all because they are similar to the typical typeface. For example those students that aimed that adapting Gothic letters seems not do any modification to the letters. They only copied or duplicated exactly what is displayed in the computer's screen. There are others that have slight modification which may not be easily observed unless when closely and meticulously checked.

In Table 11, four (4) out of the twenty (20) participating students decided to use CAD beyond expectation. These four (4) participating design students probably considered the use of CAD as the ultimate. 50 % of the participants used CAD below expectation while 30% used CAD moderately as it is expected. It can be assumed that female (M =2.13, SD = .641) may adhere to the instruction than the male (M = 1.47, SD = 0.793).The rate of CAD usage among male and female have significant difference (t(-2.104), p = 0.050, which is equal to the significance level α = 0.05). Therefore, we can suggest that the mean scores for the two categories (male and female) are different regarding how CAD inspiration relates to the letter geometric modification.

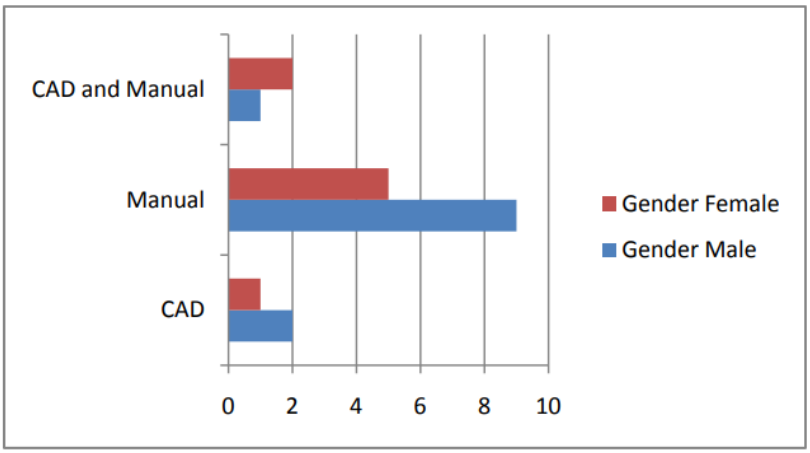

Figure 19: *Harnessing CAD and manual approach for the letter modification in relation to gender*

Thus, generating ideas for letter modification through the suggested procedures has more effect on the female than male in terms of compliance (see Figure 19). The male might refused to comply because they do not think it is necessary while the female might have complied because the instructor require that it should be done. Thus, female may be performing better than male, simply because they may be abiding by the rules or principles more than the male counterpart. Although, among those that refused to use CAD also include those that have low CAD proficiency. Only six (6) (i.e. 30% of the participants attempted using CAD moderately as instructed (see Table 11).

In Figure 20, participants with low flexibility are those that used only manual approach while those with high level of flexibility are among harnessing CAD and manual approach.

In Table 12, it can be inferred that the flexibility of the students and the use of design brief as procedure are effective during the CAD inspiration (for design brief, ANOVA is (F (1.18) = 0.084, p = 0.776); and for flexibility, ANOVA is (F (1.18) = 0.325, p = 0.576)). Meanwhile, participants using CAD only and manual only are among those that fail to adopt the drafting of design brief for their project. Participants who used CAD and manual together for letter modification adopt the drafting of design brief (see Figure 21) and they are flexible as well (see Figure 20) and there is no enough evidence to support the claim that there is difference between the mean for students' flexibility; since, 0.325 is less than 0.576. Likewise, 0.084 is less than 0.776. Thus, it is likely that the suggested procedure have significant effect on the student's creative letter design especially when they are flexible and not when they are unyielding.

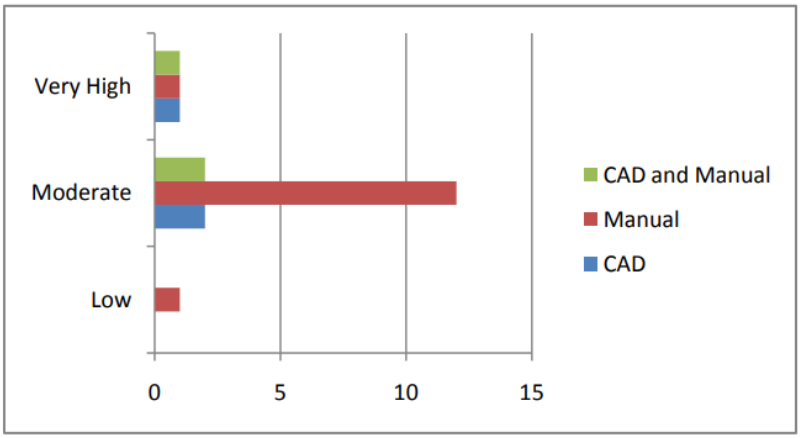

Figure 20: *CAD Inspiration for Letter design Geometric Modification in Relation to the students' Flexibility*

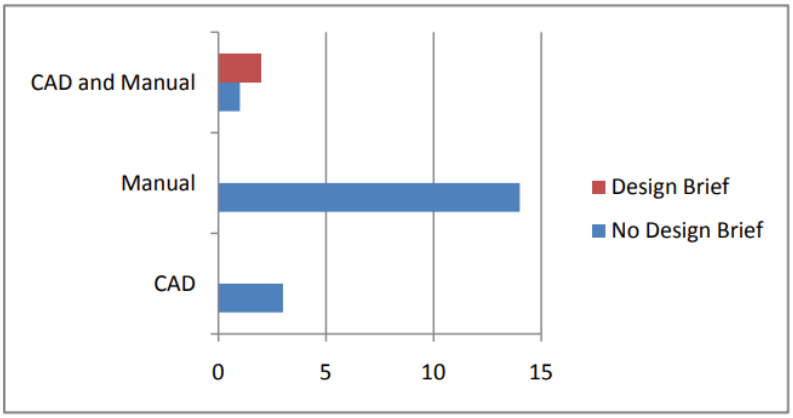

Figure 21: *CAD Inspiration for Letter design Geometric Modification in Relation to the use of Design Brief*

Table 12: *Overview of the Effectiveness of the Suggested Procedure by using One Way ANOVA*

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Mentorship as a Procedure	Between Groups	.008	1	.008	.059	.811
	Within Groups	2.542	18	.141		
	Total	2.550	19			
Intuition	Between Groups	.033	1	.033	.040	.843
	Within Groups	14.917	18	.829		
	Total	14.950	19			
Understanding of the Procedure	Between Groups	1.200	1	1.200	1.271	.274
	Within Groups	17.000	18	.944		
	Total	18.200	19			
Sketching as a Procedure	Between Groups	61.633	1	61.633	2.061	.168
	Within Groups	538.167	18	29.898		
	Total	599.800	19			
Rate of CAD Usage	Between Groups	2.408	1	2.408	4.427	.050
	Within Groups	9.792	18	.544		
	Total	12.200	19			
Motivation of the Student	Between Groups	2.700	1	2.700	2.663	.120
	Within Groups	18.250	18	1.014		
	Total	20.950	19			
Interest of the Student	Between Groups	1.875	1	1.875	3.418	.081
	Within Groups	9.875	18	.549		
	Total	11.750	19			
Appropriateness of Design	Between Groups	.533	1	.533	.655	.429
	Within Groups	14.667	18	.815		
	Total	15.200	19			
Flexibility	Between Groups	.208	1	.208	.325	.576
	Within Groups	11.542	18	.641		
	Total	11.750	19			
Design Brief as a Procedure	Between Groups	.008	1	.008	.084	.776
	Within Groups	1.792	18	.100		
	Total	1.800	19			

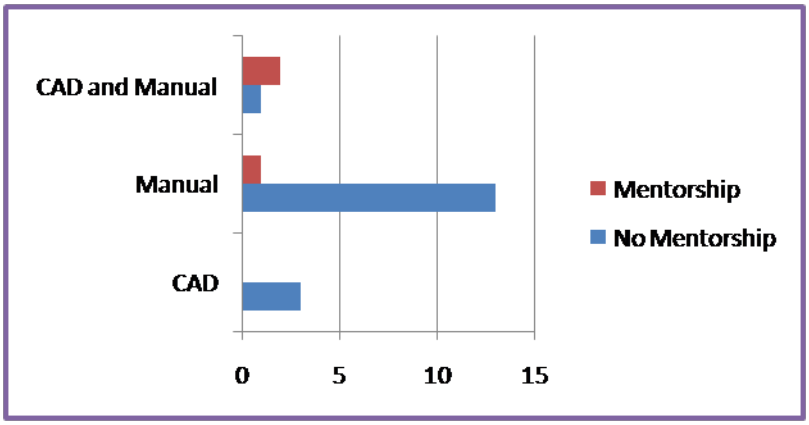

Figure 22: *CAD Inspiration for Letter design geometric modification in relation to mentorship*

The one way ANOVA conducted to compare the mean of the criteria proves the effectiveness of the suggested procedures and shows (F (1.18) = .059, p = .811) in terms of how mentorship affected the student works' during CAD inspiration for letter design. Participants who used CAD and manual (see figure 22) for letter modification adopted mentorship in similar pattern and there is no enough evidence to support the claim that there is difference between the mean; since, 0.059 is less than 0.811. In figure 22, majority fail to show the need for mentorship especially among those fail to follow the suggested procedure appropriately. This may be one of the problem that made them to use CAD in such a way that seems not to reveal significant and interesting originality in their paper work. The one way ANOVA shows (F (1.18) = 4.427, p = .05) in terms of rate of CAD usage. That is, majority of the participants fail to behaviour in similar pattern in terms of using CAD and there is difference among the means. Some of them used CAD excessively above expectation; some failed to use CAD; and some used CAD below expectation. CAD inspiration is expected to increase their motivation to create unique letterforms that will not result to similarly-looking paper works. It is as if the works are done by the same person. The one way ANOVA shows (F (1.18) = 2.663, p = .120) in terms of the students' motivation. There is high variability in the students' level of motivation .i .e. majority of the participants fail to behaviour in similar pattern in terms of motivation and there is difference among the means. Two participants have very high motivation as result of using both CAD and manual. If the remaining 18 participants used CAD and manual probably they may be motivated to produce works devoid of similarly appearance and will not be copying another students' work.

In Figure 22, majority fail to adopt mentorship but there is the likelihood that if the participants adopt mentorship, the originality will be more distinctive. Thus, it is likely that the suggested procedures have significant effect on the student's creative letter design. In table 12, the one way ANOVA conducted to prove the effectiveness of the suggested procedures shows (F (1.18) = .040, p = .843) in terms of how the students' intuition become useful during CAD inspiration for Letter design. Participants who used CAD and manual (see figure 23) for letter modification are able to use their intuition in similar pattern and there is no enough evidence to support the claim that there is difference between the mean; since, 0.040 is less than 0.843. Thus, it is likely that the suggested procedure have significant effect on the students' intuition during the creative letter design in geometric modification. Figure 23, shows that the students are able to use high level of intuition as result of the CAD inspiration. The intuition is only moderate when it is only done manually but very higher when CAD is harnessed with manual. (see Figure 23).

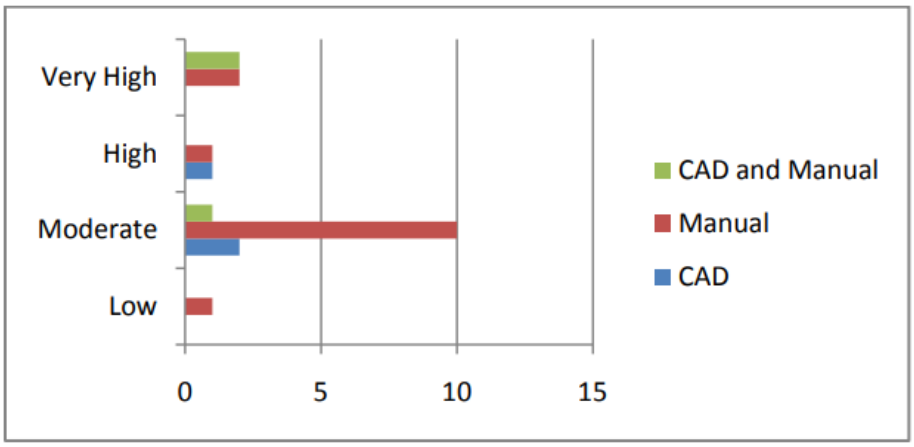

***Figure 23**: CAD Inspiration for Letter design geometric modification in relation to the students' intuition*

The one way ANOVA conducted to compare the mean of the criteria proves the effectiveness of the suggested procedures and shows (F (1.18) = 1.271, p = .274) in terms of the students' understanding of the procedures. This becomes useful during CAD inspiration for the letter design. There is high variability in the students' understanding of the procedure .i .e. majority of the participants fail to behaviour in similar pattern in terms of understanding and there is difference among the means. For instance, it seems they do not understand the suggested procedure perfectly but those using both CAD and manual have very good understanding of the procedure (see figure 24). Thus, the suggested procedure is still effective; even though, it can be inferred that majority of students may not like the new procedure because of it several tasks like sketching, drafting of design brief and to mention a few that may be lingering, difficult or not interesting to them. If participants adhere to the suggested procedures, it is expected that CAD inspiration will enabled them to have better performance than what they have actually done during this exercise. For instance, figure 25 shows that those harnessing CAD and manual approach have high performance but there are few that complied.

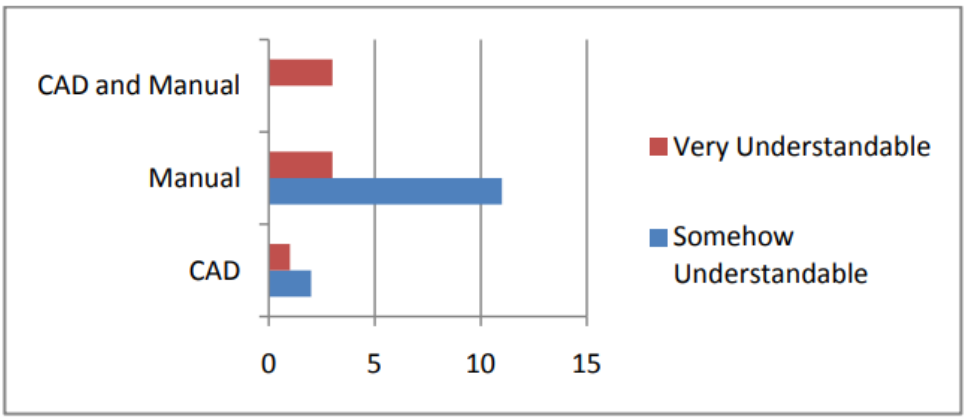

***Figure 24:** CAD inspiration for letter modification in relation to the students' understanding of the procedures*

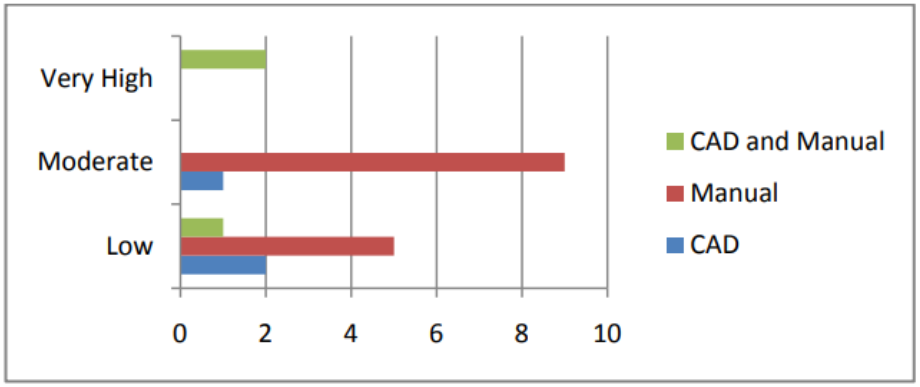

Figure 25: *Level of Performance as result CAD inspiration for letter modification*

These few participants that complied are those that produced the appropriate design. Table 10, shows (F (1.18) = 0.655, p = 0.429) in terms of the appropriateness of design. Thus, there is enough evidence to support the claim that there is difference between the mean for students' appropriate design produced; since, 0.655 is greater than 0.429. Likewise, there is high variability in the other criteria such as design students' motivation, the usage of CAD, sketching, appropriateness of design, and the interest of the student. This means they are significantly different. Majority of the participants fail to behave in similar pattern and there is difference among the means. For instance, one way ANOVA shows (F (1.18) = 1.271, p = .274) in terms of the students' interest. There is high variability in the students' interest. In figure 26, it seems those using only manual or CAD are indifferent and not prompted to harness CAD and manual together but those using both CAD and manual are interested in the procedure (see Figure 26). Thus, for the effectiveness of the suggested procedure, the interest of the student is very important. Also, if the suggested procedures are appropriately practiced the design students will definitely produce appropriate design especially for the letter modification.

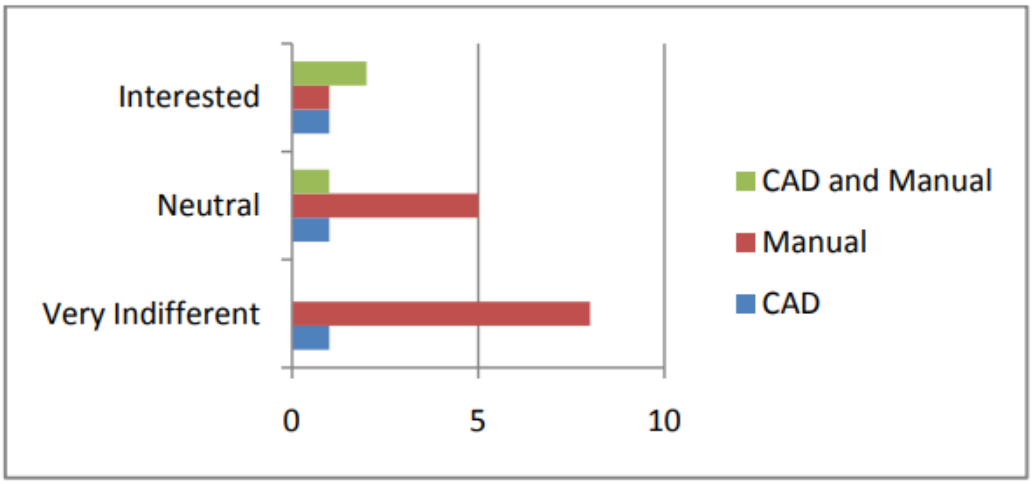

Figure 26: *CAD inspiration for letter modification in relation to the students' understanding of the procedures*

Conclusion

This study explores geometric modifications in letter design to foster originality and creativity among design students. The aim is to encourage students to view Computer-Aided Design (CAD) as a tool to enhance their intuition and reduce reliance on copyrighted materials. It is believed that this approach will make lettering project more interesting and encouraging for the student to draw on paper as well as making use of CAD as penultimate. The findings show that few students recognized the importance of adequate attention to letter design, and many faced challenges due to inadequate access to technology. The study demonstrates the effectiveness of CAD in enhancing geometric modification processes and emphasized the importance of anatomy in typography. During the illustration both uppercase and lowercase transformation are showcased. The influence of Computer-Aided Design (CAD) is evident throughout the illustration process which include the use of existing typefaces and original designs created without copyrighted typefaces. CAD tools significantly enhance the geometric modification process for both categories of letter designs. However, their impact on design principles is more pronounced in original designs created without existing typefaces, underscoring the importance of CAD inspiration in adhering to and emphasizing design principles in such contexts. Thus, the student outcome will enable students to create display and decorative letters for various applications, including outdoor spaces and editorial designs, independently by building their personal identity for the new letterform without entirely depending on existing typefaces. Also, CAD inspiration played a crucial role in emphasizing anatomy in both categories. This affirms the importance of the knowledge of anatomy in typography for creating unique appearance and structures of the letterform. Procedures such as drafting design briefs, seeking mentorship, and combining CAD with manual techniques are suggested to encourage creativity and originality. This means that this method enabled the moderate use of CAD and it serves as a means of encouraging students to develop more ideas. By sketching only, students may not produce several ideas but when the application of CAD is involved students tend to provide more ideas accompanied with the sketches. The study reveals that combining CAD with manual techniques enhanced students' intuition and creativity in letter design. Statistical analysis indicated that the suggested procedures had a positive effect on students' creative output. However, adoption of these procedures is low, and male students show less compliance. Thus, design educators should explore ways to engage both male and female students more effectively to minimize the effect of gender difference in design education. Design educators should also establish mentorship programs and adopt methods that emphasize creative thinking and originality. The study recommends addressing technological barriers and exploring ways to engage male students more effectively. Also, the suggested procedures such as design brief for students' project should be encouraged. Section can be included in the design brief where students can state areas where they need mentorship. Further studies can explore the use of emerging technologies, compare manual and digital techniques, and investigate cultural influences on design education. Such research can propose solutions for overcoming barriers to technology access in under-resourced institutions. Instead of the English alphabets, logo design, brand signatures and other distinctive design variables can be used in further studies. By pursuing these areas of further study, researchers and educators can continue to enhance the effectiveness of design education, ensuring that students are well-prepared for the evolving demands of the design industry.

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Conflict of Interest: None declared.
Ethics Committee Approval: N/A

Author Contributions: The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.
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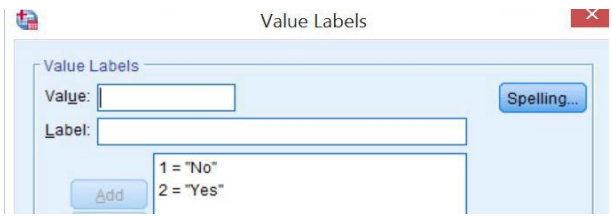
APPENDIX A

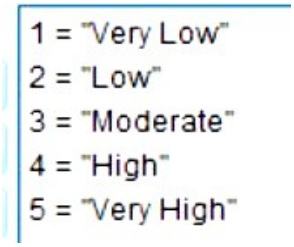
List of Abbreviation used in the Appendix B
G = Gender
F = Female
M = Male
NOS = Number of sketches
MTHD = Method
RCU = Rate of CAD Usage
IDP = Fundamental Design Principles
WC = Well Considered
AC = Averagely Considered
NC = Not Considered
I = Interest
U = Understanding
INT = Intuition
F = Flexibility
DB = Design Brief
MET = Mentorship
MOV = Motivation
A = Appropriateness
O = Originality
IOI = Interpretation of Instruction

APPENDIX B

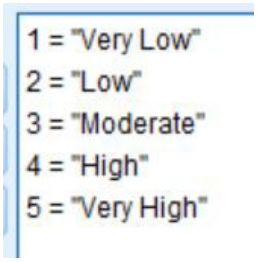
Values used for Design Brief (DB) and Mentorship (MET) as used in the IBM SPSS Statistics 23



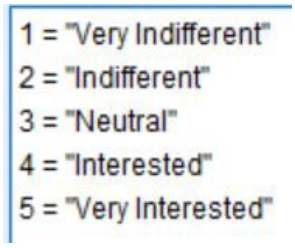
Rating Scale for Intuition (INT) as used in the IBM SPSS Statistics 23



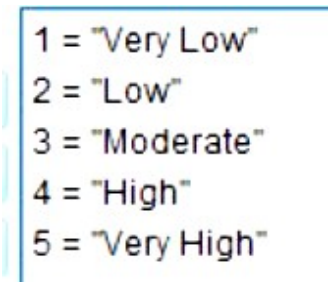
Rating Scale for Flexibility (F) as used in the IBM SPSS Statistics 23



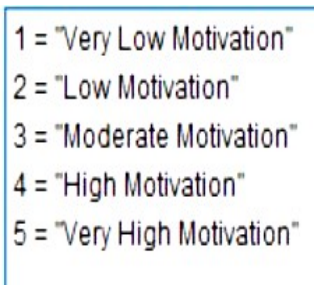
Rating Scale for Interest (I) as used in the IBM SPSS Statistics 23



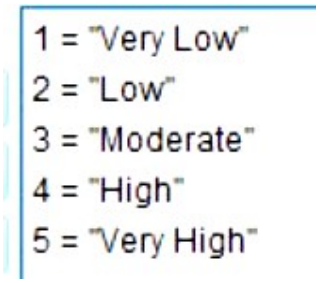
Rating Scale for Interpretation of Instruction (IOI) as used in the IBM SPSS Statistics 23



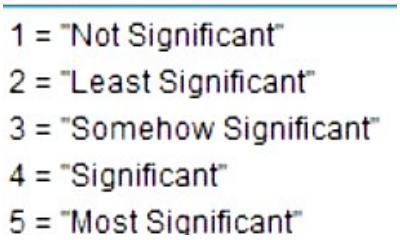
Rating Scale for Motivation (MOV) as used in the IBM SPSS Statistics 23



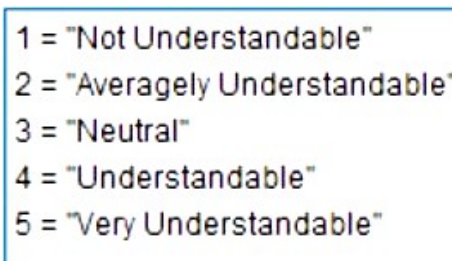
Rating Scale for Appropriateness (A) as used in the IBM SPSS Statistics 23



Rating Scale for Originality (O) as used in the IBM SPSS Statistics 23



Rating Scale for Understanding (U) as used in the IBM SPSS Statistics 23



Some Data Collection for the study

G	NOS	MTHD	RCU	FDP	I	U	MOV	A	O	IOI	INT	F	DB	MET
F	6	Manual	low	WC	3	3	3	2	2	3	2	2	1	1
F	15	Manual and CAD	Excessive	AC	4	5	5	2	3	3	5	5	2	1
F	10	Manual	Moderate	NC	3	5	5	3	3	3	3	3	1	1
F	8	Manual	Moderate	WC	3	3	3	3	3	3	3	3	1	1
F	9	Manual	Moderate	N C	3	3	3	3	3	3	4	3	1	1
F	13	Manual	Moderate	AC	3	5	3	3	3	3	3	3	1	1
F	21	Manual and CAD	Moderate	WC	3	5	3	5	3	3	5	3	1	2
F	0	CAD	Excessive	N C	3	3	3	3	3	3	3	5	1	1
M	4	Manual	Low	AC	2	3	2	2	3	3	3	3	1	1
M	15	CAD	Excessive	AC	4	5	4	2	3	3	3	3	1	1
M	4	Manual	Low	AC	2	3	2	3	3	3	4	3	1	1
M	13	Manual and CAD	Low	AC	4	5	5	5	3	3	5	3	2	2
M	1	Manual	Low	AC	2	3	2	3	3	3	3	3	1	1
M	7	Manual	Low	AC	2	3	2	3	3	3	3	3	1	1
M	5	Manual	Low	AC	2	3	3	2	3	3	3	3	1	1
M	14	Manual	Low	AC	4	5	4	3	3	3	5	5	1	2
M	3	CAD	Excessive	AC	2	3	2	2	3	3	3	3	1	1
M	1	Manual	Low	AC	2	3	2	2	3	3	3	3	1	1
M	5	Manual	Moderate	AC	2	3	2	3	3	3	3	3	1	1
M	8	Manual	Excessive	AC	2	5	3	2	3	3	3	3	1	1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Gender	20	1	2	1.40	.503
Sketching as a Procedure	20	0	21	8.10	5.619
Rate of CAD Usage	20	1	3	1.70	.801
Application of Design Principle	20	1	3	2.00	.562
Interest of the Student	20	2	4	2.75	.786
Understanding of the Procedure	20	3	5	3.70	.979
Motivation of the Student	20	2	5	3.05	1.050
Appropriateness of Design	20	2	5	2.80	.894
Interpretation of Instruction	20	3	3	3.00	.000
Intuition	20	2	5	3.45	.887
Flexibility	20	2	5	3.25	.786
Design Brief as a Procedure	20	1	2	1.10	.308
Mentorship as a Procedure	20	1	2	1.15	.366
Geometric Modification Under Two Categories	24	1	2	1.50	.511
CAD inspiration in terms of design principles	12	3.0	5.0	4.167	1.0299
CAD inspiration in terms of anatomy	10	3.0	5.0	4.000	1.0541
CAD inspiration in terms of geometry	24	.0	5.0	3.917	1.7173
originality	20	2	4	3.00	.324
How the student used CAD	20	1.00	4.00	3.0000	1.02598
Valid N (listwise)	10				

APPENDIX C

Other Examples of Paper Works Produced by the Participants

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Unfolding the Rhythm: Transmediary Thinking in Design

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DOI: 10.46474/jds.1479620 https://doi.org/10.46474/jds.1479620

Abstract: This paper explores the intersection of sound and space in first-year design education through the "Unfolding the Rhythm" project. Sound is viewed as a dynamic force that shapes subjective experiences of time and space, creating invisible connections between people, objects, and places. The project captures sounds related to stories of escape from daily life, organising them into speculative spatial narratives using a digital audio workstation. These auditory tales are then translated into spatial notation drawings, which are further transformed into three-dimensional sound topographies within a predefined volume. This fluid void, representing non-hierarchical and open-ended layers of topography, becomes a component of the spatial narrative inspired by Jorge Luis Borges' "The Immortal." The story's spatial descriptions are intentionally omitted, with students detailing and reproducing these spaces in the void defined by subsequent sections. The singularity of each space influences the emergence of cross-sectional interactions that transform the collective topography of the story, creating a reversed process of space construction through cuts, sections. The resulting models, reflecting spatial intervals in "The Immortal," contribute to the evolution of transmediary spaces. This sectional thinking offers students a novel approach to the architectural design process. The workflow defined here involves cross-media transitions and imaginative gaps in translation that embrace diverse potential futures, non-linear cause-effect relationships, and organisational forms. As a result, the project considers temporal processes instead of static objects, topological formations instead of geometric operations, and new ways of thinking about materiality by seeking an immaterial approach to making space within auditory dimensions.

Keywords: First-year design education, Soundscape topography, Section, Translation, Design process

1.Introduction

Sound generates emergent, evolving, and relational spatialities. Depending on the listener and their experience, sound fills time and space subjectively, forging an invisible topography that connects people, objects, and places. This paper delves into the "Unfolding the Rhythm" project, which uncovers the interplay between space and sound in first-year design education held in Architectural Design Studio at MEF University in the fall term of the academic year of 2022-2023. The fall semester of 2022-2023 is structured around three projects: unfolding the room, unfolding the rhythm, and unfolding the wall, with project goals and outcomes aligned to an annual thematic focus (Figure 1).

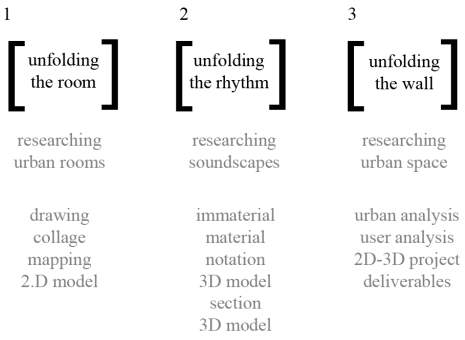

***Figure 1**: 2022-2023 fall semester Architectural Design Studio I projects and targeted outcomes. (Diagram by Irem Naz Kaya)*

Unfolding the Rhythm, the second project of the semester, aimed students to develop their individual and collective learning processes in design education through sectional thinking and material experiments.

It explores the material/immaterial and topographical encounters of soundscapes through stories of escape. The project, phase by phase, constructs these spaces through cross-media transitions and architectural operations that conceptualise sound as the atmospheric space-making element. Moreover, in parallel with the change of media, the series of instructions given do not remain as mere translations but re-creations carrying traces from previous tools and mediums with each iteration.

The project begins by capturing sounds and audio recordings of various events and objects related to stories of escape encountered in daily life. These sounds of escape stories constitute the beginning of the research that will turn into the bases of the escape places in The Immortal story (Borges, 2013), which will be reconstructed to create the narratives of escape in the second phase of the project. These escape narratives encompass various forms, redirecting the daily flow, and seeking refuge from undesirable places, and each one represents a spatial accumulation of the sounds individuals experienced in their daily lives or encountered along their journey. While escape narratives trigger the plotline and initiate an unknown journey, they also align with our approach to design pedagogy. Escape is defined in the Oxford Dictionary as "breaking free from confinement or control" (Oxford University Press). Crafting an escape story differs from a challenge in that it compels its author in a reverse sense, demanding a departure from conventional narrative constraints.

2.Methodology of the Project: Designing the Studio Instructions

Design studios are at the core of the curriculum at MEF University where students are active engagers-tellers and listeners. Telling and listening take the form of "reciprocal reflection-in-action" where students both design and learn to design through learning-by-doing (Schön, 1984). Recently, this learning-by-doing approach has evolved alongside new technologies and digital culture, indicated by Bob Sheil, promoting progressive education. These technologies empower students to expand their imaginations and apply knowledge across diverse disciplines, transforming them into "hybrid disciplinarians." This transformation encourages a critical approach to design and fabrication (Sheil, 2015). By engaging in production processes through technological experimentation and research, students bridge the gap between academic learning and practical application. This integration of educational discoveries with technological advancements provides new tools and opportunities for students to meet practical needs across various fields.

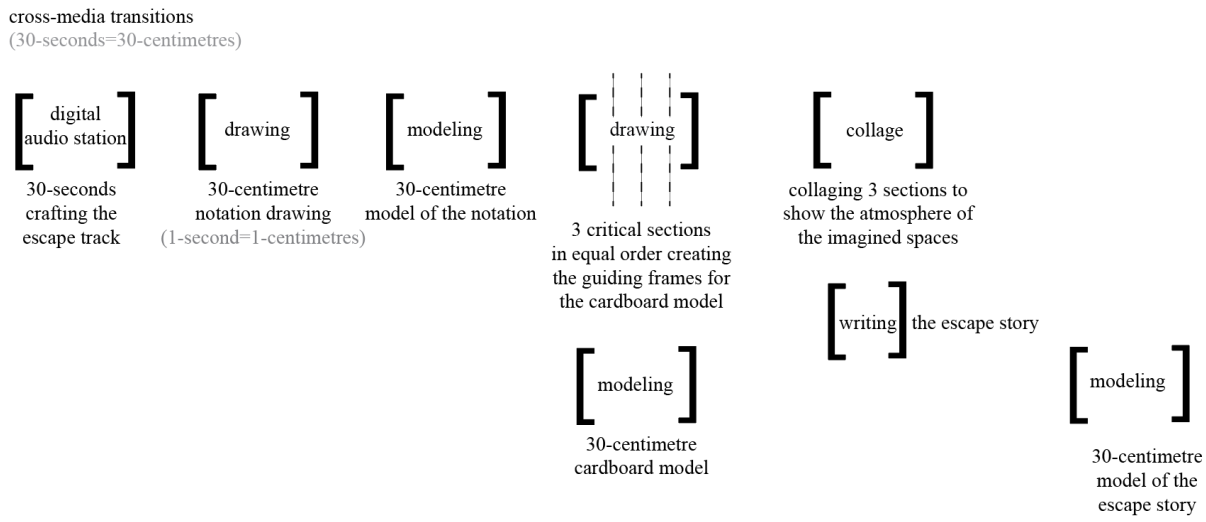

Figure 2: *Methodology of the studio: Series of instructions, designing the cross-media transitions. (Diagram by Irem Naz Kaya)*

This adaptation is curical as traditional educational goals and methods often fall short in supporting both learning and societal transformation (Froud & Harriss, 2015). Unlike conventional approaches where researchers pose questions and seek answers, design research frequently begins with generative processes (Rendell, 2021). Consequently, there has been a shift towards endorsing research that spans multiple disciplines and embraces interdisciplinary approaches. Interdisciplinary research challenges disciplinary boundaries by involving individuals from various fields, fostering innovative perspectives that critique established power structures and promote alternative knowledge frameworks (Rendell, 2021). In line with this shift, the Unfolding the Rhythm project explores interdisciplinary intersections of sound, literature, and architecture within a studio framework using transmediary representations. The investigation of transmedia transitions in architectural design processes within design studios represents a significant research area, as studio culture is characterized by dynamic, interconnected layers rather than static boundaries.

To date, various approaches have been explored regarding the interdisciplinary relationship between architecture and sound, particularly how the soundscape influences design education (Fowler, 2013). In *"Spaces Speak, Are You Listening?"*, Blesser and Salter highlight the concept of "the aural architect," who designs environments that evoke emotional and behavioural experiences of space, fostering social and cultural cohesion among occupants (Blesser & Salter, 2007). It is evident that sound initiates research that transcends boundaries in design education, enabling architectural practice to move towards atmospheric and multisensory design spaces. In this research, rather than solely defining space by its physical confines, attention shifts to intangible and experiential boundaries through a series of operations. Figure 2 outlines the overall phases, revealing these operations and instructions (recording, drawing, modeling, collaging, writing) aimed at creating new confrontations and encounters. Introducing mechanisms that do not confine students to predetermined paths, especially within first-year design education, helps avoid inherent deadlocks within the discipline itself. Moreover, encountering other disciplines such as sound while engaging with one's own discipline fosters more open-ended learning, eliminating control mechanisms for both students and instructors.

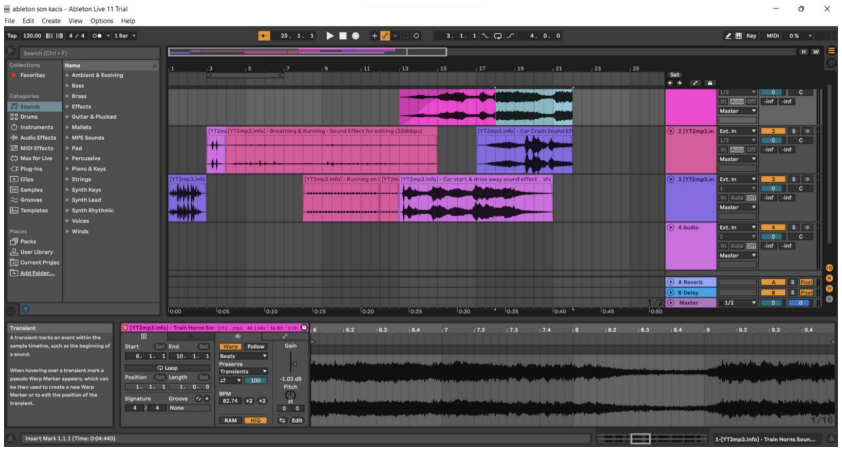

***Figure 3**: Student working on 30-second escape track in Ableton Source: (Ege Ringo) (Screenshot from Ege Ringo's Ableton interface)*

The workflow defined here involves cross-media transitions and imaginative gaps in translation that embrace diverse potential futures, non-linear cause-effect relationships, and different ways of organising the space. As Robin Evans points out, the transmission of ideas in architecture never occurs seamlessly; there is always a gap between drawing and construction, and the deviations caused by that gap. When translated from drawing to construction, it often serves a projection function (Evans, 1996). Moreover, according to the Stoics, the gap is an unlimited openness that enables objects and their qualities to remain in place while providing room for interactions among them and be seen as an immaterial condition that makes materialism possible. (Kousoulas 2022). As mentioned by Evans and Kousoulas, the gaps occurring between transitions across media in this project trigger creativity and imagination. Therefore, this gap or deviation is seen as a way of re-establishing new relationships, allowing for the inclusion of what deformed in the previous step by repairing it while keeping traces with each iteration. As a result, the project paves the way for considering temporal processes instead of static objects, topological formations instead of geometric operations, and new ways of thinking about materiality by seeking an immaterial approach to making space within auditory dimensions.

2.1. Designing the 2D and 3D Transitions

As mentioned in the previous section, this project takes off with an open-ended instructional series, which is a designed workflow for the studio process such as recording sounds, manipulating them by accelerating, slowing down, reversing, trimming, cropping, and thus "creating a musical composition derived from an escape story." Collected recordings are arranged and curated within a digital audio workstation (Ableton) to craft 30-second speculative spatial stories that transport the listener to imaginary territories. Ableton facilitated students' interaction with sound volumes by manipulating speed rates and applying clipping techniques, thereby addressing the temporal aspects of the designed auditory experience (Figure 3). Ableton was chosen not only for its user-friendly interface that allows easy sound modification but also for its ability to visualize the relationships between different sounds layer by layer. This capability helps establish the sound-visual connection and provides a background for the notation drawings that will later be required from the students.

By using concepts such as loop -*a repeating section of sound material*- (Wikipedia) and pitch -*the perceived quality of a sound that is chiefly a function of its fundamental frequency—the number of oscillations per second (called *Hertz, abbr. Hz) of the sounding object or of the particles of air excited*

***Figure 4**: Editing grid of Ableton showing the visual translation of sound*
Editing Grid of Ableton: cdm.link. (2023, November). *Ableton Live 12: Everything new*. Retrieved from https://cdm.link/2023/11/ableton-live-12-everything-new/

by it- (The Harvard Dictionary of Music, 2003), students started to construct their spatial stories. Later, the escape tracks are converted to spatial notation drawings which, according to Allen (2009), are subjective instructions transcending time and space, combining spatiality and materiality. The notation drawings serve as a transformative device, allowing the author to represent the intangible and establish a relational interface. This interface, in turn, creates soundscapes by translating auditory dimensions into visual drawings. Although Ableton illustrates the relationships between sounds through its editing grid, the visuals it presents are diagrams reflecting measurable, numerical values of sound, such as loudness and the active time intervals of instruments. These diagrams lack information about the emotion and mode of the sound, and therefore do not possess the subjectivity found in notation drawing (Figure 4).

Moreover, the process of notation drawing empowers students to initiate their design by

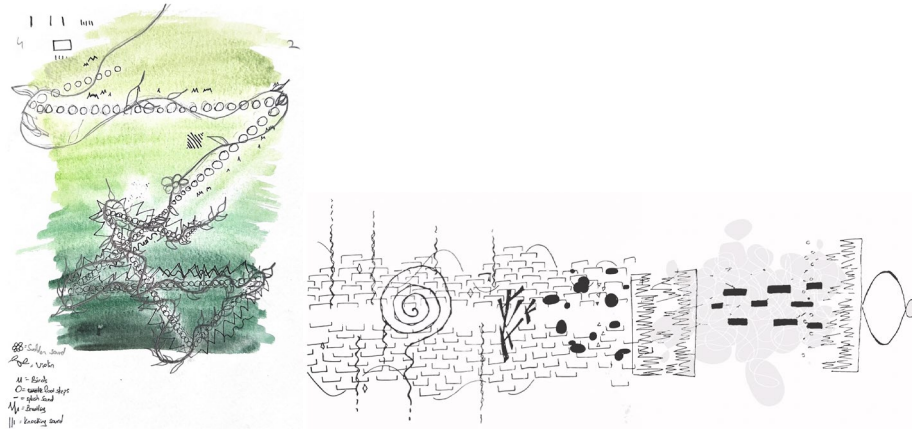

***Figure 5**: 30-centimeter notation drawings built second by second corresponding to 30-seconds of escape track. Drawing on the left: Escape from the forest, encountering the sounds of nature, space and time flows vertically in this story Source: (Yagmur Kirca); Drawing on the right: Escape from the keyboard sounds in the office, space and time expands at different rates and flows horizontally Source: (Nisan Tekin) (Drawing on the left by Yağmur Kırca, drawing on the right by Nisan Tekin)*

rendering an intangible layer visible. Notation drawings reveal a dynamic flow of time, adopting diverse directions and line weights as they encounter the musical realm. Within this flexibility, notation drawings play a crucial role, providing first-year students with precise information to guide them when navigating the unpredictable territories of design thinking. Simultaneously, students learn to distinguish abstract concepts, such as emotions, mood descriptions, or adjective clauses during this translation process and explore spatial configurations that indirectly generate these states and concepts (Figure 5).

Later, these two-dimensional notations are transformed into three-dimensional sound topographies within a predefined volume of 15 cm (width) - 15 cm (height) - 30 cm (length). The 30-centimetre length serves to capture the temporal flow of a 30-second track, while the width and height dimensions are employed to represent the qualities of sound such as intensity, depth, or volumetric resonance. The 3D-model study of the first phase plays an important role in comprehending, analysing, and reproducing the atmospheric continuity of the sound. The 3D model transforms the intangible spatial qualities of the sound into a topography. As Hill (2006) mentioned, “a sound can be as tangible as an object” since it generates its material and immaterial layers. In the next phase, the topography of sound is explored by contour lines which transform the immaterial qualities of sound topography to tangible contour lines. Eventually, as the number of contour lines increases to cover the whole atmospheric qualities of sound, the transition from intangible layers to tangible ones defines a derived topography from the original one. This phase of the project is critical as it questions the relationship that architecture establishes with materiality by defining architecture through immaterial conditions. The idea of creating space by transforming the immaterial into material is introduced in the Air Architecture Manifesto (1959). This manifesto envisions all transient materials becoming building materials; daylight, air and any gas heavier or denser than air, magnetism, sound, smells, magnetic forces, and electricity—all can be seen as a building material and considered equally with the material layers like brick and concrete to construct the space. Similarly, Moholy-Nagy argues that space can be understood as relations among different materials, offering a new perspective on the concept of material itself. He asserts that space lacks independent existence, quoting physics: "space is the relation between the position of bodies." However, he places greater importance on the relationships between spaces rather than the bodies themselves, stating that "space creation becomes the nexus of spatial entities, not building materials." Building materials are auxiliary and can only be used to create spatial relationships to a limited extent. Space itself is the primary tool for creation. Moholy-Nagy describes space as "this material" and emphasizes that "the phrase 'material is energy' will have significance for architecture by emphasizing relation, instead of mass." He contends that recognizing matter as energy shifts focus to space as a kinetic force-field of fluid relations and minimal substance, making space the material of immaterial architecture (Hill, 2006).

Describing architecture through the interplay of immaterial and material layers not only indicates a redefinition of space but also suggests a reconsideration of the design process, which is prompted in the studio process with sectional cuts.

2.2. Designing the Cuts

Some academics contend that there is an intriguing connection between architectural cross-sections and human dissections (Angelopoulou, 2017). For architects, plans and sections serve as tools that unveil the spatial layout, just as an x-ray exposes the internal organization of the human body (Zylinska, 2021). The introduction of cross-sections into the architect's toolkit marked a new era in how architectural objects are internally organized, establishing a dialectical relationship between surface and depth. In essence, architecture has historically involved intellectually "cutting through" buildings to give them material form, making "cutting through buildings" an essential part of the construction process. Architects use

cuts as a "generative enactment," in the words of Eva Hayward, and as a form of becoming—a way to "feel the growth of new margins" (Angelopoulou, 2017).

For instance, in his Arcades project, Benjamin explores how nineteenth- and twentieth-century apartments function as protective shells for their inhabitants, akin to compass casings or shells. However, this casing represents a threshold between interior and exterior spaces. While it appears to be purely protective, it is also displayed and projected outward, like items in a shop window or museum artifacts. The once quiet, secure, and intimate bourgeois interior has transformed into an exterior facade. Benjamin suggests that no matter where it is opened or cut, the house remains a facade, stating that “arcades are like houses or passages that have no exterior, like the dream” (Teyssot, 2005). Benjamin establishes a relationship between urban interiors created by arcades and the visibility provided by sectional cuts. The section transforms every public space into an interior with the layers it encompasses, such as sewer lines, water and gas supply, and metro tunnels, while revealing Victorian interiors as facades. According to Teyssot (2005), through the cut, these interiors become reversible surfaces, which can be transformed into exteriors. These cuts serve as a critical threshold in topology, delineating between the interior and exterior. Thus, Benjamin emphasizes the relationship of visibility that the cut establishes with windows that allow observation of the exterior. He uses the cut as a mode of revelation, asserting that ‘any form of observation depends on the act of making the cut’ (Barad, 2003).

Moreover, according to Hernan Barria Chateau, the cutting of a building to make an observation, did not remain a mere matter of intellect within architectural history (Chateau, 2011). In the 1970s, this concept moved from theory to reality when Gordon Matta-Clark famously dissected buildings, bringing the idea of building cuts into the physical realm. Matta-Clark transformed a suburban family house in New Jersey, set for demolition, into the sculpture "Splitting" (1974). Cutting from foundation to roof, he divided floors, walls, and stairs, flooding the interior with light and creating a dramatic architectural state that foretold its impending demolition. The Cutouts weave time, light, nature or the street into the abandoned building. By cutting into the architectural fabric, Matta-Clark was able to better comprehend it and demonstrate the cuts' ability to reorganize itself, resulting in intricate and unexpected spatial outcomes. He uses the cut to highlight its pervasive complexity and create novel perspectives by allowing immaterial layers to alter the understanding of the building, space. For Matta Clark the cut, or the incision which occurs in an existing structure or a design drawing, unveils the mystery of solid-void, encompassing both the known and the unknown. This incision not only reveals hidden layers but also provides an opportunity to imagine the undefined and design the unknown. Thus, the void that the incision unveils, transcends its Cartesian dimensions and represents a highly fluid field, encapsulating serial, non-hierarchical, and open-ended layers.

Moreover, the cut has a temporary dimension as it suspends in space, creating different temporary planes that imperceptibly stabilize and reconstruct a storyline. This capacity of the section to reconstruct is described as evolving and generative, as Debaise and Bergson discuss. According to Debaise (2012), the cut, or section, initially constructs a temporal plane that 'extracts from a part of an ongoing experience' and has the potential to evolve and incorporate beyond. Similarly, for Bergson, every section corresponds to regimes of individuation and relation, making it generative by continually attempting to reconstitute and transform through cutting or extracting, thus introducing a new situation. As Mark Wigley (2017) points out, Matta Clark's cut is a unifying operation that 'connects spaces around a line' rather than an action that separates or disperses.

Looking at the literature on this entire section, we employ the concept of the section and cut to generate ideas, shape matter into specific forms, and organize these forms into coherent wholes. Sectional cuts play a transitional role in the

process of the Unfolding the Rhythm project. Following the composition of the sound topographies, students draw three sections highlighting instances where the model exhibits the highest complexity. Progressing with sectional cuts carries traces from further examples where section and void relationships are examined. In the next phase, three sections are transferred onto cardboard and inverted; the positive space within the section drawings is cut out, revealing the negative space that corresponds to the voids in the sound topography. The spaces between the sequentially acquired sections are opened up, revealing a defined void where the fourth dimension can permeate.

2.3. Writing the Collective Narrative

We use the narrative of Jorge Luis Borges' story to create a new space between the sections. In this phase of the 'Unfolding the Rhythm' project, akin to Barad, we view the cut as a 'boundary-drawing practice' (2007). This perspective opens a dialogue for interdisciplinary thinking between literature and architecture. According to Lim (2013), literary theory and literature have significantly influenced architecture education in the past two decades. From Italo Calvino's Invisible Cities (1972) to Roland Barthes's 'The Death of the Author' (1968), writers and their works have inspired a generation of architects to use both real and imagined as creative springboards. CJ Lim's London Short Stories aims to push architecture to its limits by integrating fundamental elements of fiction. This research combines design and text, using narrative as its primary medium. It employs original materials inspired by literary symbolism to design and articulate urban spaces, blending theory with practical application in a unique approach.

Text is often underutilized in architectural design, typically serving an explanatory rather than expressive role. However, in this project, text is innovatively employed as a creative tool, shaping narratives that transform two-dimensional sheets of paper into intricate, sometimes surreal stories. Each narrative begins as a flat surface and evolves through cutting, inscription, folding, and fusion into multidimensional tales. Text and collage, or text and photographs thereof, interact in complex ways—sometimes aligning, sometimes diverging—to explore various facets of the story's potential meanings and interpretations (Figure 6).

Figure 6: *A page from CJ Lim Short Stories.*
(CJ Lim Short Stories.Domus. (2011, November 6). Short stories: London in two and a half dimensions. Domus. Retrieved from https://www.domusweb.it/en/reviews/2011/11/06/short-stories-london-in-two-and-a-half-dimensions.html)

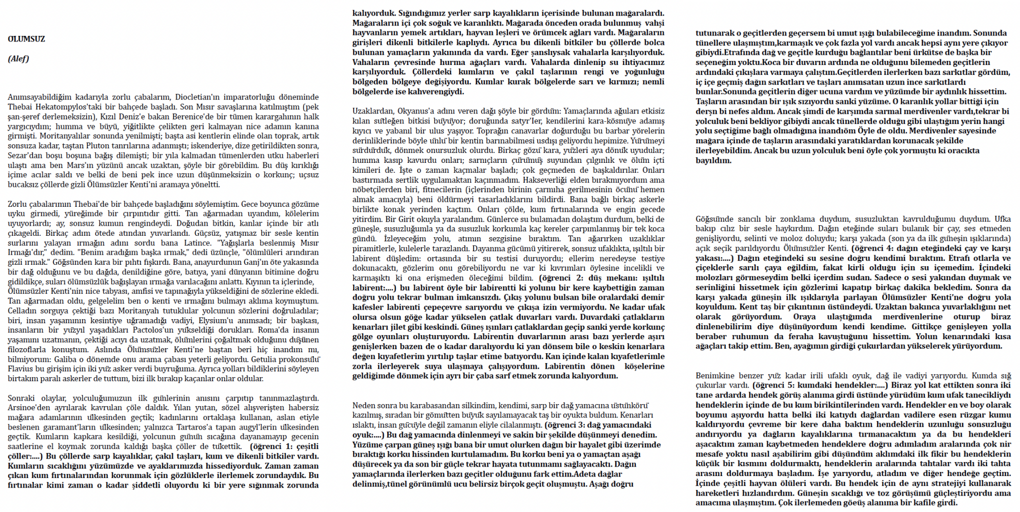

***Figure** 7: Each student describes the spaces in the Immortal story in detail and the story is written collectively by 12 students. Bold texts refer to students' descriptions of their imagined spaces. (Collective story, by Emine Hatun Aktaş, Emre Koçar, Gözde Defne Kocaman, Sumru Yaren Cav)*

Similarly, like CJ Lim, we use Jorge Luis Borges' short story 'The Immortal' to explore new spatialities, considering changes in spatial practice that could be truly transformative. Before distributing the story for students to study, the spatial descriptions in the story are intentionally omitted, and its paragraphs depict different spatial configurations such as "the cave", "the village", "the desert", "the labyrinth" etc. in the storyline. The spatial descriptions are one by one distributed in the studio. Each student describes these spaces by writing a spatial narrative in detail and reproduces them in the void defined by three subsequent cardboard sections placed in equal order (Figure 7).

The arrayed sections create the guiding frame in which the spatial narrative will be constructed by a physical model. This model materialises the narrative and builds a precisely scaled topography that refers to a subsequent spatial interval in the modified "The Immortal" story. Additionally, the singularity of each space contributes to the evolution of another space sequentially. This, in turn, facilitates the emergence of cross-sectional interactions and transformations between spaces. Thus, the process of constructing one space is inverted into another space, revealed through an architectural operation (section), allowing sectional thinking to guide in exploring a new approach to designing the space.

Sections that establish neighborly relations assist students in collectively shaping the atmosphere, interactions, and transitions. "The atmosphere of the space, verbally described in the narrative, encompasses layers of life, material, and immaterial characteristics within each section. This atmosphere is crafted not only through modeling, hand drawing, and collage but also through the integration of these representations, capturing the entirety of the space's atmosphere. Different episodes within the selected story are spatialized through the Doppler effect, as discussed by Somol and Whiting (2002), creating an atmospheric space that relates not only to each other but also extends beyond the program it initially presents. According to Somol and Whiting, the concept of interdisciplinarity in architecture seeks to validate architecture through external measures, potentially reducing it to a mere absorber of diverse life influences. Projective architecture, however, redefines architectural identity based on design and its impacts rather than traditional material and procedural norms. Doppler shifts

Figure 8*: The spaces in the storyline of the Immortal story are designed and modeled side by side by the students within the cardboard sections. (Collage by Irem Naz Kaya)*

the notion of disciplinary autonomy towards a practice-oriented view where disciplines are dynamic and continually evolving. Doppler emphasizes architecture's diverse multiplicities—materiality, programming, atmosphere, and technology—highlighting how these complexities differ significantly from approaches in other disciplines. This approach focuses not just on object qualities but also on sensory and experiential dimensions.

Considering the Doppler effect, the space crafted by 12 students placed side by side, created using sections from both the previous and the next, reveals the entire escape story. Each space holds equal significance in this story and is arranged without hierarchy. In this collaborative process, each student designs a spatial interval contributing to a larger whole beyond their individual action radius (Figure 8). Even though it requires a certain level of collective work with their 'neighbours'; the hidden agenda of this work depends on an altered collectivity based on multiplicity of individual explorations in the studio setting.

As the students encounter a design problem that requires translation from abstract narratives to tangible ones, they observe 11 other ways of coping with this complex situation that will later come together and form a whole. This observation enables them to invent and settle in their own individual ways of designing in a supportive environment.

Our design pedagogy shows similarities with the concept of the section previously mentioned, which was described as temporal and generative. Similar to the section, our series of instructions generate temporal frameworks for students, allowing them to reinterpret and overcome challenges at each phase they

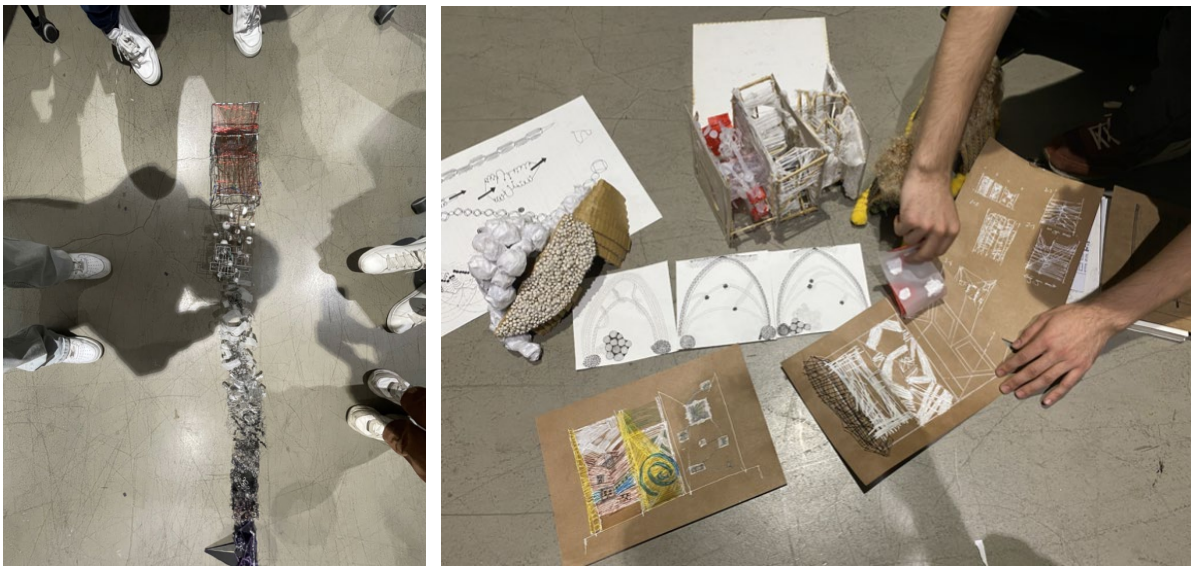

Figure 9*: Photographs from the studio. Collectively crafted models on the left; Student (Ali Haydar Ararut) work consisting of material research describing the atmosphere of the place in different sections on the right. Source: (Irem Korkmaz)*

***Figure 10**: Student work showing all phases of the project (Notation drawing on the top; models on the left; sectional drawings on the right) Source: (Dilara Koybasi)* (*Drawings and model by Dilara Koybasi)*

cooperate with. Reinterpretation and distortion in each phase are crucial to the overall process of this project and serve as a motivating approach for students at the beginning of their educational journey. Figure 9 illustrates the final works of a student, from notation drawings to the representation of the spatial interval.

3.Conclusions and Critical Reflections

Although starting design practice in unconventional ways was a positive side of the "Unfolding The Rhythm" project, understanding the relationship between sound and space was quite challenging for the first-year design studio. Consequently, contemplating the testing of the project for more advanced stages became a topic for consideration in future studies. Reflecting on experiences in the first phases of the project, we found the introduction of a non-architecture design discipline and actively transitioning between multiple disciplines to be very enriching in the process. Since students were unable to predict the next step in the project brief and could not rely on their previous strengths, they delved into more authentic investigations. The student's command of design tools from another discipline at various levels enabled them to gain a critical distance towards their design process. On the other hand, starting speculation on the space from

notations, resulted in more spatial qualities as stated from the unthought.

"Unfolding the Rhythm" contributes to future studio approaches focusing on the design process and iterations rather than the final product. This approach helps students engage continuously without singling any out, fostering collaboration on common ground. Recognizing each narrative as an escape story underscores viewing unknown situations not merely as outcomes of human actions but as integral parts of life. This perspective necessitates establishing interdisciplinary connections and design workflows, facilitating the emergence of hidden voices and transforming immaterial inputs into tangible outcomes. For Doucet and Janssens (2011) this approach emphasizes transcending traditional disciplinary boundaries and organizes knowledge around complex and heterogeneous domains rather than disciplines and subjects, resulting in knowledge that surpasses the sum of its disciplinary components. For us, this transforms design research into an interdisciplinary and generative process, diverging from conventional approaches where researchers pose questions and seek direct answers. It promotes the power of experimentation and research at each phase of the project.

In conclusion, the "Unfolding the Rhythm" project sought a reflective and innovative shift in the traditional design process through its exploration of the interplay between space and sound in first-year design education. By initiating architectural thinking from the material and immaterial dimensions of soundscapes, the project aimed to transcend conventional disciplinary boundaries, introducing students to cross-media transitions and imaginative gaps in translation. The emphasis on sectional cuts as a transitional tool aimed to challenge the established norms of architectural materiality, prompting a reevaluation of the relationship between immaterial conditions and the physical realm. Even though the decision to embark on unconventional design practices, while enriching, posed challenges in comprehending the relationship between sound and space for first-year design students, the project's evolution, as seen in its iterations and adaptations, reflects a commitment to continuous learning and improvement.

"Unfolding the Rhythm" has been a transformative exploration, challenging the boundaries of disciplines by questioning the possibility of material and sectional translations through narrative. As we reflect on these experiences, the project emerges as an advocate for a shift in perspective, urging us to view design as a dynamic process rather than a static outcome. This shift in thinking may not only enrich design pedagogy but also empower students with the ability to navigate the complexities of design thinking, thereby enduringly expanding investigation.

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XR Experience in Architectural Design Studio Education: A Systematic Literature Review

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Abstract: Pursuing innovative methods in architectural education continually evolves in response to the profession's dynamic and changing demands. Today, Extended Reality (XR) technologies are emerging as powerful tools with the potential to transform design studio education fundamentally. Focusing on "Extended Reality (XR)" rather than individual terms like VR, AR, and MR is due to XR's encompassing nature. Using all realities collectively allows for a comprehensive evaluation of their synergies. Each reality has distinctive capabilities, and their combined use may offer a richer educational experience than focusing on them individually.

This study examines the use and impact of XR technologies in architectural design studio education (ADSE), exploring how conventional components can evolve with XR from 2019 to 2024. It highlights XR's influence on design studio education and experiential learning, guiding students, educators, and researchers at the intersection of XR and ADSE.

The authors conducted a systematic literature review following the PRISMA (2020) checklist (Page M.J.et al.,2021). Searches in three primary databases resulted in 183 articles. After identifying and removing duplicates, 178 abstracts were reviewed, and full texts were examined. Ultimately, three articles related to “XR Experiences in ADSE" were subjected to detailed analysis.

The research found limited studies with the “the impact of the XR in architectural education" keyword. Following the systematic review, three articles remained. These articles were assessed to investigate the use of XR technologies in design studio education. The reviewed articles generally indicated positive outcomes from using XR technologies in one or more components of design studio education.

Keywords: Architectural design education, XR technologies, XR integration in architectural education, Extended reality, Quality education.

1. Introduction

Architectural design studio education is the linchpin of pedagogical evolution within the architectural domain. Rooted in the historical evolution from conventional mentorship to its contemporary status, this educational model epitomizes a complex interplay of components. Its adaptability to emerging technological paradigms, particularly “Extended Reality” (XR) technologies, presents a significant trajectory deserving detailed investigation. This systematic literature review seeks to delve into

the integration and implications of XR technologies within architectural design studio education, offering comprehensive insights into its multifaceted impact.

In architectural pedagogy, the term “studio” embodies a dual essence: it signifies a physical space for learning activities and a pedagogical methodology reminiscent of an artist’s studio (Crowther, 2013) (1). This multifaceted notion delineates the studio as a crucible where future architects engage in experimental exploration, fostering collaborative problem-solving skills (Akyıldız, 2020) (2). Unlike conventional classroom settings, studios nurture analytical synthesis and evaluative modes of thought essential for architectural creation (Dutton, 1987) (3). Over time, this educational framework has evolved in response to technological advancements, particularly the advent of computer-aided design (CAD), marking a transformative phase in pedagogical strategies. The evolution of studios is underscored by adaptable infrastructure and the integration of personal computing devices, reshaping conventional educational landscapes. The convergence of architecture and computer science has precipitated groundbreaking alternatives to physical reality, notably Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), collectively termed Extended Reality (XR) (Reffat, 2007) (4).

Despite these technological strides, there exists a need for more exhaustive research examining the nuanced integration and repercussions of XR within architectural design studio education. This systematic literature review aims to fill this gap by illuminating the utilization of XR technologies within these educational contexts. Focusing on the timeframe from 2019 to 2024, coinciding with pivotal technological advancements, this study aims to provide nuanced insights into XR’s integration and impact on architectural design studio education.

Employing a meticulous three-stage systematic review encompassing 183 abstracts sourced from Science Direct, Scopus, and Web of Science databases, this study rigorously scrutinizes the influence of extended reality technology on design studio education. By exemplifying exemplary applications of digital technology within design studios, it endeavors to shed light on associated benefits and challenges and contribute substantively to the evolving discourse on XR’s role in architectural education.

2. Methodology

Systematic Review Methodology is used in this study. As defined by Petticrew and Roberts (2006) (5), systematic review methodology is a meticulous and transparent approach to analyzing information from multiple studies that address a specific research question. It involves a systematic search, careful selection, and critical evaluation of relevant literature, followed by a comprehensive synthesis of the findings. A systematic review produces a reliable and unbiased summary of the available evidence by reducing bias and adhering to a predetermined methodology. This methodology enables informed decision-making and identifies potential areas for further research.

To thoroughly investigate the utilization and effects of XR technologies in Architectural Design Studio Education, the research questions "How are Extended Reality Experiences Utilized in Architectural Design Studio Education?" and "What Effects Do They Have on Experiences?" were formulated. These questions clarify the study's objectives and guide the research process. A systematic literature search was conducted using PRISMA (2020) guidelines to address these questions. Searching on Science Direct, Scopus, and Web of Science databases -based on their extensive coverage, reliability, advanced search capabilities, citation tracking, interdisciplinary insights, and analytical tools -focus on studies published between 2019 and 2024, when digital technology gained significant momentum and increased use. Keywords relevant to the research question were used to identify relevant literature.

Studies within this timeframe that specifically explored experiential learning in architectural design studios, particularly utilizing extended

reality (XR) technologies, were selected for inclusion. The most frequently used digital technologies in these studies were identified, and those focusing on XR technologies, which offer various tools and environments, were prioritized.

This study's reporting adheres to the PRISMA (2020) (Page M.J.et al.,2021) guidelines, ensuring transparency and comprehensive reporting of the systematic review process. By following this methodology, the study aims to provide an evidence-based understanding of the impact of digital technology on experiential learning in architectural design and culture.

2.1 Eligibility Criteria

The evolution of design studio education is an intricate interplay of diverse influences, refraining from unilateral outcomes. This study investigates the imminent trajectory of architectural design studio education, scrutinizing the intricate components inherent in exploring XR technology's role within this domain. Emphasizing the consequential impact of these investigations, the research seeks to provide a comprehensive understanding of XR's implications on architectural design studio education and culture. By synthesizing this information, the study aims to furnish invaluable insights to stakeholders in the field, contributing significantly to the scholarly discourse and the progression of the discipline. This systematic exploration, encompassing literature from Science Direct, Scopus, and Web of Science, maintains rigorous criteria for inclusion and exclusion (Table 1).

2.1.1 Inclusion Criteria

This systematic literature review considers architecture or design education studies, focusing on architectural design studio education, culture, and the integration of XR (Extended Reality) technology. The included investigations delve into the application, effects, or integration of XR Technologies within architectural design studio education. The selected researches explore the influence of XR experiences on various facets of architectural design studio culture, including tools, methodologies, interactions, and outcomes. Articles published in English

Table 1: *Systematic Literature Review Results in Science Direct, Scopus, WoS Databases.*

Database	Query Terms	Type	Research Area	Category	Results
Science Direct	the impact of XR on architectural education (2019-2025 and Eng.)	review art., research art.	Eng., Comp.Sci., Decis.Sci., Soc. Sci., Env. Sci., Psychol.	Eng., Env. Science, Psychol.	79
Scopus	the impact of XR on architectural education (2019-2025 and Eng.)	article	Soc. Sci., Arts, Psyc., Multidiscip.	Eng., Comp. Sci., Soc. Sci., Arts Humanit., Psychol., Multidiscip., Env. Sci.	85
Web of Science	the impact of XR on architectural education, XR technologies and architectural design education (2019-2025 and Eng.)	review article, article	Arch.	Eng., Civ. Eng., Constr. Eng., Build. Technol., Env. Sci., Arch., Edu. Educ. Res., Eng. Env., Env. Stud., Archaeol., Eng. Multidiscip., Comp. Sci. Interdiscip. App., Psychol., Multidiscip., Imaging Sci. Photogr. Tech., Remote Sens.	19
				TOTAL	183

between 2019 and 2024 will be considered. Inclusion criteria were applied by focusing on XR and architectural design studio education on most related papers. Studies conducted during this specified period that specifically examined the use of experiential learning in architectural design studios, focusing on utilizing extended reality (XR) technologies, were selected for inclusion. The digital technologies most commonly employed in these studies were identified, and those that concentrated on XR technologies, which provide a range of tools and environments, were given precedence.

2.1.2 Exclusion Criteria

Literature not centered on XR technologies, studies unrelated to higher education, works not directly associated with architecture, and off-topic or divergent studies will be excluded from this review. Specific papers selected for inclusion must align with the review's focus on XR technologies in architectural design studio education. Non-English language studies and duplicate publications will be excluded. These criteria ensure a systematic literature review, emphasizing the selection of pertinent and rigorous sources essential for an extensive exploration of XR experiences in architectural design studio education.

The systematic literature review followed a well-defined procedure involving the distinct identification, screening, and inclusion stages. This methodological rigor facilitated the elimination of numerous articles based on specific criteria: duplicates (n=5), scholarly works deviating from the domain of extended reality (n=98), content unrelated to the of higher education (n=98), material not focused on the discipline of architecture (n=47), studies conducted outside the field (n=26), and particular research papers that did not align with the primary objectives of the review (n=2) (Fig. 1).

Duplicated papers: 5, Literature that is unrelated to XR technologies:2, Literature that is unrelated to higher education:98, Literature that is unrelated to architecture:47, Off-field studies: 26, Specific papers which are irrelevant to the aim of the review:2.

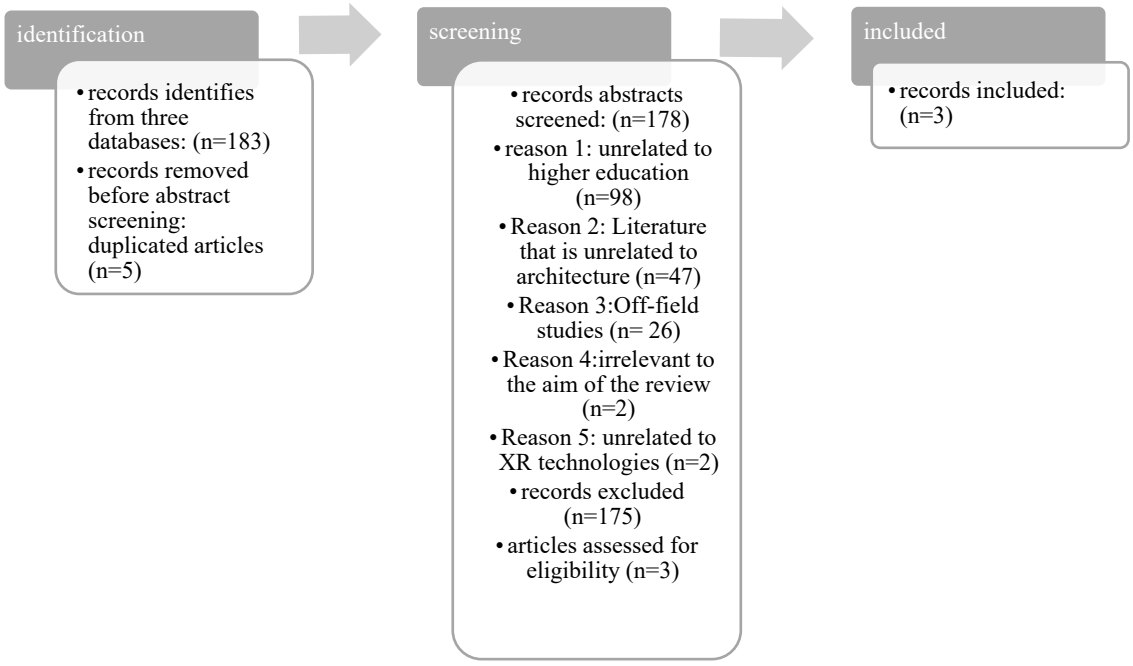

Figure 1: *Adapted Prisma Flow Diagram*

The systematic literature review process identified three papers that are most related to this study's aim. To evaluate papers and their reviews and determine the utilization of XR technology in architectural design studio education, three main titles were created to assess: method, aim, and conclusion (Table 2).

Paper 1: Darwish, M., Kamel, S., & Assem, A. (2023). Extended reality is used to enhance spatial ability in architecture design education. Ain Shams Engineering Journal, 14(6), 102104. https://doi.org/10.1016/j.asej.2022.102104. (6)

Paper 2: Kharvari, F., & Kaiser, L. (2022). Impact of extended reality on architectural education and the design process. Automation in Construction, 141, 104393. https://doi.org/10.1016/j.autcon.2022.104393. (12)

Paper 3: Spitzer, B. O., Ma, J. H., Erdogmus, E., Kreimer, B., Ryherd, E., & Diefes-Dux, H. (2022). Framework for the use of extended reality modalities in AEC Education. Buildings, 12, 2169. (28)

Review papers and review of these three papers are examined with the criteria as focus, XR experience, XR tools, and conclusion and projection comments to investigate whether enhancing the components of conventional design studio education using XR technologies is possible and beneficial.

2.2 Paper 1: Extended Reality for Enhancing Spatial Ability in Architectural Design Education, Darwish et al., 2023 (6)

In Paper 1, experimental research carried out in this paper aims to conduct an empirical study in architectural education to assess the impact of XR technology on students' spatial ability. The study's findings reveal enhancement among those who utilized XR technology, unlike a control group that did not exhibit any alterations in their spatial competence scores. Furthermore, the paper comprehensively examines existing literature about using XR technologies in architectural design education, encompassing these previous applications' objectives, methodologies, conclusions, and limitations.

Table 2: *Included papers' main frame.*

Paper	Method	Aim	Conclusion
1.**Darwish** et al.**, 2023**	Review + Research	to explore the benefits and drawbacks of incorporating this technology in the initial stages of architectural design and assess its influence on student performance.	XR significantly improved students' spatial abilities and enriched architectural education by reducing cognitive burden.
2. **Kharvari** and Kaiser**, 2022**	Systematic Review	to examine the effects of XR technologies on architectural education and investigate how XR technologies influence the design process.	XR tech helps architectural ed by enhancing learning and design.
3. **Spitzer** et al., **2022**	Literature Review & Framework	to create proposed framework for AEC educators to integrate XR technologies into teaching methods	XR tech can enhance AEC education. A model suggests XR modalities to aid instructors. XR can boost perseverance and interest. The framework needs continuous updates due to rapid XR development.

In the experimental research phase of this paper, the authors undertake a case study to investigate the influence of XR technology on spatial ability within the educational process of architectural design. To provide the VR experience, the authors utilized the VR-Oculus2 HMD and the Gravity Sketch Application, while for the AR experience, they utilized the iPad and the Augment Application. Second-year architecture students selected randomly from Ain Shams University were chosen to partake in an experiment to evaluate the impact of extended reality (XR) on spatial abilities. Participants engaged in augmented reality experiences as part of their design studio activities, utilizing either an iPad Pro or a smartphone. Spatial ability tests were administered before and after the XR-assisted sessions, with the overall scores as the dependent variable. To enhance the presentations and facilitate life-size virtual walkthroughs, the study utilized Immersive Virtual Environments (IVE). However, a notable limitation was identified in the XR system's incapability to simultaneously accommodate multiple users, thus affecting the collaborative nature of student interaction during the study.

In the review phase of this paper, the authors present a collection of previous papers that employed XR applications, offering insights into the aims, methodologies, findings, and significant limitations of each study under review. According to analysis, literature reviews examining virtual reality (VR), augmented reality (AR) technology, and mixed reality (MR) technology applications as XR technologies in the design process converge on the consensus that these technologies improve the understanding of dimensions, proportions, and design. Moreover, participants commonly perceive the utilization of VR and AR as a motivating, enjoyable, and thrilling experience. The authors assess five relevant studies that employ applications for integrating extended reality in architectural design education.

This study examined the paper and assessed the reviews of the papers in question from an alternative standpoint to assess the implementation of XR technology within the context of architectural design studio education. This evaluation was conducted within the framework of the study's focus point, which included considerations of XR experience, XR tools, and, ultimately, the conclusion.

As a result of evaluation, studies focus on improving spatial ability, immersive learning & teaching, pedagogy, representation & criticism, informal approaches, and environmental developments; XR technologies used as VR, AR, MR, or VR & AR technologies; for VR technology Oculus Quest2, HTC Vive devices used as HMD and Gravity Sketch App, Unity Engine, GIS used as applications & software, for AR technology iPad & smartphones used as devices and Augment used as application; for MR technology HMD used as a device and scanning tool used as application. The conclusions of these studies can be categorized as positive and negative. The positive impacts of using XR technologies are enhancing the educational process for architectural design, creating a desire to learn, and leading to improved design education pedagogy. The negative impacts of using XR technologies are technical challenges as the system cannot handle multiple users simultaneously, which limits interaction; the IVE was only used for the critique sessions, not for the design process itself; students saw the AR tool as a challenging tool for integration in architectural education as a tool for representation, lacked the time necessary to understand the program entirely (Table 3).

Table 3: *Paper 1 (Darwish et al., 2023: "Extended Reality for Enhancing Spatial Ability in Architecture Design Education") and review summaries.*

Study	The Focus of the Study	XR Experience	XR Tools	Conclusion & Projection Comments
Rev. Darwish et al.**, 2023**	XR -technologies application on architectural experiences	various	various devices & apps	various: mentioned below
Res & Exp. Darwish et al., **2023**	improving the spatial ability of students	VR & AR for element design (as a part of design problem)	VR- Oculus Quest2 (HMD)&Gravity AR–iPad&Augment	+: enhancing the educational process -: technical challenges
Nisha, **2019**	pedagogy	VR for city spatial development maps	VR HDM and GIS	+: enhancing design pedagogy
Zhang and Chen**, 2019**	immersive learning and teaching	VR environment to interact with designs	VR – HTC Vive, Unity, and VR package	+: creating a keen to learn -: limited multi-user support
Sopher et al., **2019**	representation & critics	AR/IVE for presentation & critics (life-size experience)	AR- Immersive Virtual Reality Env.	+: increased productivity in design activities -: used for the critique sessions
Fonseca et al., **2016**	informal approaches	using AR for representation	Not mentioned	+: students were enthusiastic about technology -: AR integration challenges
Lu and **Ishida, 2020**	environment development	MR to create VR furnishing on scanned real world	MR- Scanning tool and HMD	+: system receives favorable feedback

2.3 Paper 2: Impact of Extended Reality on Architectural Education and Design Process, Kharvari and Kaiser, 2022 (12)

In Paper 2, the study comprehensively examines the influence of extended reality (XR) technologies on architectural education and the design process outcomes. It classifies the findings into four distinct course types and posits that XR technologies positively affect various design stages and facilitate architectural learning. Utilized PRISMA (2020) checklist guidelines and a modified PICO strategy for systematic review and research question formulation. Included user studies on AR/VR in architectural education, excluding conceptual studies without participants.

The study emphasizes that VR, AR, and MR are transforming industries, including education. VR is defined as an immersive computer simulation, AR overlays digital information, and MR blends physical and virtual interactions. XR technologies have shown potential in various educational fields, but their integration into architectural education needs more consensus. This study aims to

systematically review XR technologies' impact on architectural education and the design process.

The data extraction for the reviews included defining the authors of the articles and publication years, the design of the studies, the fields of application, the software and devices utilized, the specified results, and the number of participants. The articles were classified into four categories: "Construction and Building Science," "Design Education," "Lecture Courses," and "Other Courses and Applications."

The findings of the authors' investigation reveal that implementing XR technologies in architectural education leads to enhancements in both learning outcomes and student performance. Moreover, using VR, AR, and MR in this context positively influences the design process. XR technologies present students with an experience centered around their needs, resulting in substantial advancements in learning. To be more precise, immersive VR enhances spatial perception compared to non-immersive environments.
In the ideation stage, VR improves critical thinking and problem-solving. AR enhances the ability to mentally rotate objects, thus aiding in comprehending spatial relationships. MR, on the other hand, facilitates the evaluation and reflection stages of the design process. The employment of XR technologies fosters a more effective retention of architectural precedents. Additionally, VR stimulates contemplation on design, leading to an enhancement in the overall design process. Lastly, XR technologies are crucial in assessing created spaces' experiential and evaluative aspects. More research is needed to quantify the impact of XR tech on creativity and idea generation (Table 4).

Table 4: *Paper 2 (Kharvari, F., & Kaiser, L. (2022). Impact of extended reality on architectural education and the design process) and review summaries.*

	The Focus of the Study	**XR Experience**	**XR Tools**	**Conclusion & Projections Comments**
Kharvari and Kaiser**, 2022**	XR - technologies (VR, AR, MR) application on architectural experiences	various	various devices & apps	+: affordability, efficiency, enhanced learning in architectural education with XR tech. -: creativity, idea generation, psychological studies required XR effects
Kharvari and Hohl, **2019**	space/site visit/built-environment experience	serious gaming using VR applications for 3D architectural visualization	VR-HTC Vive & Unreal Engine	Not mentioned
Ozgen et al., **2019**	learning problem solving	VR for basic design education	VR- Oculus RiftDK2, Google Blocks	VR boosts problem-solving in interior architecture
Hopfenblatt and **Balakrishnan, 2018**	teaching problem solving	VR as an instruction tool for foundation studios in learning, adapting, and prototyping	VR- ZSpace, HTC Vive, Nine Cube VR	+: useful for design creation, simplified teaching without 3D software
Llorca et al.**, 2018**	teaching importance of sound in urban spaces	urban acoustics education	VR- Oculus Rift, music	+: enhanced satisfaction, and space awareness via VR, opportunity to feel-in-place

Huang et al.**, 2018**	learning/exploring about an urban space	integrating agent-based modeling with VR for learning	VR- HTC Vive	+: enhanced design process
Abu Alatta and Freeman, 2**017**	Learning early design process	enhancing spatial perception within the design process with IVE	VR-General, Oc.Rift, Unity3D	+: improving performance, creativity, and overall design quality
Fonseca et al.**, 2017**	Motivation	tech adaptation of the student with 3D visualization	Not mentioned	+: advanced visualization improved motivation
Valls et al.**, 2017**	Exploring/creating/experiencing	improving student motivation	AR- Unreal Engine 4	+: gamification or serious game strategies in VRE creates motivation
Paes et al.**, 2017**	Experiencing/exploring	IVE for understanding of architectural 3d models	VR & IVR-3D model, VR techs	+: IVR provides better spatial perception conventional
Sun et al.**, 2017**	Experiencing architecture in VR /AR	VR technologies for online architectural education	Not mentioned	+: VR technologies are better than conventional
Fonseca et al.**, 2016**	Experiencing via VR-AR-DS hybrid	informal interactions in 3d education	AR/VR/DS/HM	+: boosted motivation, enhanced graphics & spatial skills for academic success
Valls et al.**, 2016**	Learning via VR	Videogame technology for learning	VR- Unreal Engine 4	+: create a speculation to improve method and tools
Ayer et al.**, 2016**	Experiencing design via VR, AR and conventional	AR gaming for sustainable design education	VR/AR – Game ecoCampus	+: reduced time frustration, diverse design thinking breaks fixation
S´anchez Riera et al., **2015**	Evaluating presentations on site by using AR	Geo-located teaching using AR	AR- 3d models	+: low degree of immersion provided by these devices
Yoon and **Chandrasekera, 2015**	Teaching drawings by using AR	AR in design communication	Not mentioned	+: teaching orthographic projection with AR, enhancing spatial skills

2.4 Paper 3: Framework for the Use of Extended Reality Modalities in AEC Education, Spitzer et al., 2022 (28)

The article presents a theoretical structure for Architecture, Engineering, and Construction (AEC) instructors to proficiently incorporate Extended Reality (XR) technologies into their educational plans, amplifying the process of acquiring knowledge and fostering active participation. This proposed framework is substantiated by its implementation in a summer camp at the esteemed Georgia Institute of Technology.

AEC professions hold great significance within society, as they are regarded as highly esteemed and esteemed. Architectural Engineering and Construction Management are remarkably esteemed due to their substantial financial benefits and profound societal influence. In the realm of AEC education, XR technologies are progressively being employed to augment the processes of recruitment, retention, and student involvement. This is occurring despite the obstacles encountered in adopting such technologies and the absence of instructional guidance provided to educators.

A thorough examination of the existing literature was undertaken to comprehensively understand XR technologies and their various applications within AEC education. The authors employed the Model of Domain Learning (MDL) as a theoretical framework to connect AEC's educational objectives with XR's modalities. Subsequently, a framework for decision-making was constructed to assist AEC educators in selecting appropriate XR technologies based on their academic goals and priorities. To ensure the validity and effectiveness of this framework, it was implemented and tested during a summer camp held at the esteemed Georgia Institute of Technology's School of Building Construction. The study conducted by the authors yielded several outcomes. First and foremost, XR technologies were defined, and their advantages and disadvantages for AEC education were clarified. Second, a decision-making framework for selecting XR modalities in AEC education at a summer camp was validated. Third, it is demonstrated that XR tech can enhance student engagement, self-confidence, and learning outcomes through immersive experiences. Lastly, immersive XR modalities such as IVR and MR are particularly effective in generating interest.

In conclusion, XR technologies have the potential to significantly enhance AEC education by improving comprehension, involvement, and professional visualization. The decision-making framework assists educators in determining appropriate XR modalities for different educational objectives. Using XR to generate interest may result in heightened motivation and continued engagement in AEC curricula. Given the rapid progress of XR technologies, it is imperative to update the decision-making framework continually.

The reviewed studies generally include architectural engineering education, and there could not be any related to design education, so Paper 3's reviews are not in the framework of this study (Table 5).

Table 5: *Paper 3 (Spitzer, B. O., Ma, J. H., Erdogmus, E., Kreimer, B., Ryherd, E., & Diefes-Dux, H. (2022). Framework for the use of extended reality modalities in AEC Education. Buildings,) review summary.*

Study	The Focus of the Study	XR Experience	XR Tools	Conclusion & Projections Comments
Spitzer et al.**, 2022**	XR -technologies (VR, AR, MR) application on architectural experiences	various	various devices & apps	+: XR increases student interest and so engagement -: XR for improved learning is more complicated to achieve and measure. control groups are needed 0: XR interventions should only partially substitute the conventional teaching methods. 0: if interventions are more likely to increase engagement, self-efficiency, and learning of students.

3. Results

The synthesis of three distinct papers on Extended Reality (XR) applications in architectural education reveals multifaceted insights into its impact and utilization within design studio contexts. The results of the systematic literature review can be summarized as:

- XR technologies can be used for various pedagogical components in architectural design studios.
- XR technologies (VR, AR, MR) have been utilized individually or in combination, but no study involving all three was found.
- The use of XR technologies (VR, AR, MR) in a complementary system is limited and has mainly been applied in partial stages of the design process.
- XR technologies are limited and experimental within architectural design studio education.
- No study was found comparing experiences with XR technologies to all components of conventional design studios.
- In experiences with partial architectural design studio education using XR technologies, disadvantages related to device and hardware health effects can occur.
- Overall, experiences with partial architectural design studio education using XR technologies have resulted in positive student learning outcomes and effective teaching by instructors.
- The studies conducted within the framework of 'XR Experience in Architectural Design Studio Education' are primarily experimental, have partially addressed education components, and are limited in terms of published works.

Collective Focus and XR Experience

The papers collectively emphasize the beneficial impact of XR technologies on architectural education. While Paper 1 concentrates on enhancing spatial ability through VR and AR experiences, Paper 2 delves into the broader influence of XR (VR, AR, MR) on various design stages. Paper 3 offers a theoretical framework for integrating XR modalities (IVR, MR) into architectural education, targeting improved learning experiences and engagement (Table 6).

Table 6: *Evaluation of reviewed papers' pursuit results.*

Paper	Pursuit	Findings
1 Darwish et al.**, 2023**	enhancing spatial ability via XR experience	implementing XR technology in early architectural design education significantly enhances students' spatial ability levels
2 Kharvari and Kaiser**, 2022**	understanding Influence of XR on various design stages	XR technologies enhance learning outcomes and student performance
3 Spitzer et al., **2022**	creating theoretical framework for integrating XR modalities into architectural education	proposes a decision-making framework for AEC educators to select suitable XR technologies for various educational outcomes

XR Tools and Educational Outcomes

The tools utilized across the papers—from Oculus Quest2 and HTC Vive to iPad, smartphones, and applications like Gravity Sketch, Unity Engine, GIS, and Augment—showcased significant potential in enhancing architectural pedagogy. These tools positively influenced spatial perception, critical thinking, problem-solving, and student engagement, thereby improving learning outcomes in architectural design education.

Positive Impacts and Limitations

Overall, the studies highlight the positive impacts of XR technologies in enriching architectural education. Students perceived XR experiences as motivating, enjoyable, and conducive to enhanced learning. However, technical limitations, such as the inability of XR systems to accommodate multiple users simultaneously, hindered collaborative interactions, suggesting a need for improved multi-user capabilities for a more seamless educational experience.

4. Discussion

Despite the positive impacts, notable gaps remain. The studies mainly focus on architectural engineering education, lacking emphasis on design education. None integrated all three XR technologies (VR, AR, MR), missing a holistic approach. Addressing technical challenges and conducting comparative assessments between XR and conventional methods could provide deeper insights into XR's efficacy. Additionally, more attention is needed on the health effects of device and hardware usage in the context of XR technology.

The reviewed papers shed light on the evolving architectural design education, particularly emphasizing the transformative impact of XR technologies. Although these studies show promising results, certain critical areas require further exploration and consideration (Table 7).

Table 7: *The Summary of the impact of the XR on ADSE Systematic Review Findings*

	Findings
Educational Impact	- Enhancing students' spatial abilities (Darwish et al., 2023) - Improving critical thinking and problem-solving skills in the design process (Kharvari and Kaiser, 2022) - Increasing student engagement and participation (Spitzer et al., 2022)
Positive Outcomes	- Enhancing the effectiveness of education and improving student performance - Increasing students' learning motivation - Enriching experiential learning
Challenges	- Technical limitations, especially the inability to support multi-user environments - Health issues related to device and hardware usage - Challenges in integrating XR technologies into all educational components
Research Gaps	- Lack of studies that use all components of XR technologies (VR, AR, MR) together - Lack of studies focused on design education - Lack of comparative assessments between XR technologies and conventional educational methods
Future Directions	- Holistic integration of XR technologies in education - Improving technical capabilities and multi-user interactions - In-depth examination of health effects

Specialized Focus and Educational Context
It is important to note that the studies reviewed focused on architectural engineering education rather than design education. Future research must expand the scope to include design-centric educational contexts, as this would provide valuable insights tailored to design studio pedagogy.

Holistic Integration and Comparative Assessments
None of the reviewed papers incorporated all three XR technologies (VR, AR, MR) in a unified educational context. Taking a more holistic approach and exploring the combined impact of these technologies could yield comprehensive insights into their synergistic effects. Moreover, conducting comparative assessments between XR and conventional educational methods would enhance our comprehension of the effectiveness of XR in architectural education.

Technical Advancements and Seamless Integration
Efforts should be made to advance XR systems' technical capabilities to facilitate seamless multi-user interactions. Enhancing XR technology to support collaborative learning environments can significantly enhance its effectiveness in design studio education.

In conclusion, while XR technologies are promising to enhance architectural design education, further research is needed to address specialized design contexts, achieve holistic integration of XR technologies, and make technological advancements. The evolution of XR holds immense potential in revolutionizing pedagogical approaches and fostering enhanced learning experiences within architectural design studios.

The authors conducted a systematic literature review using the PRISMA (2020) checklist and guidelines, searching three primary databases. The research found limited studies on this topic with the keywords "XR technologies" and "architectural design education." Three articles remained after the systematic review.

Extended Reality (XR) experiences in the architectural design studio education context; this study investigated whether enhancing the components of conventional design studio education using XR technologies is possible and beneficial, how XR technologies have influenced design studio education, and if it provides valuable insights that enhance experiential learning and highlight the advantages and challenges of this innovative approach.

This study guides students, educators, and researchers in navigating the dynamic intersection of XR technologies and architectural design studio education. In the papers and their reviewed studies, it is observed that experiences were generally conducted on one or more components of design studio education; typically, one of the XR used and using XR technologies resulted in positive outcomes.

In conclusion, XR's experiences in architectural design studio education are promising. As experiments, experiences, and research progress continue, there is a high potential to develop these outcomes further, thus suggesting a solid potential for an alternative approach to conventional design studio education.

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A New Experience for Integration of Section and Model: A Case Report

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Abstract: Architectural education inherently requires continuity. The transformative power of the world, which people have experienced in the last 5 years with crises such as pandemics and earthquakes, has changed and forced the form, style and tools of this continuity. Architectural design education, which was shaped on the axis of a studio culture, had to cope with the ruptures and transitions of a new phase. This case report aims to convey an experience that brought together the adaptation of face-to-face education of the students after the online education and the section-model practice that the studio tutors have experienced before. Since the study tries to repair the correlations between the continuity, ruptures and transitions of architectural design education, integration of section and model has been re-engaged in the studio. The study group consists of architecture students who switched to online education after the February 2023 earthquakes and started face-to-face education again in the fall semester of 2023/2024. As a result, well-thought models, few experiments on the models and quick transfers to digital programs were revealed as three main tendencies in the studio. In conclusion, the adaptation of the student on the axis of continuity and to reinforce the design productivity, design problem-solving skills and the habit of doing design research tried to provide.

Keywords: Architectural Studio, Design, Model, Section.

1.Introduction

This study was prepared to convey the new versions of the reflections marked by the article, “Integration of Section and Model: Reflections from a Studio Practice” published in the Journal of Design Studio. In other words, new reflections of experience, observations and investigations in this paper are based on previous experience, coded as ‘from section-model to space’. Although the first article published in 2020 was designed as a pedagogical approach proposal to eliminate the disconnection between basic design and upper-level architectural project studios, to ensure the continuity of experimentation, and to increase the potential for discovery, this second article includes the cross-sectional spatial cycles of a process that starts with mass dynamism in the congested and problematic urban fabric using the same pedagogical approach. For this purpose, the study emphasizes the section-model experience, which is a combination of section and model. This approach also means disseminating model practices as a design tool to the architectural design studio, which has become digitalized and almost completely moving away from the model, and re-questioning alternative presentations of the

practice of thinking in the third dimension through the model.

2. Pedagogical Set-up: Preparation and Justification

The project group consists of students who took the Mim2001 Architectural Project III course in the fall semester of 2023-2024 at Sivas Cumhuriyet University, Department of Architecture. The special feature of this group is that it consists of students who started their architectural education with basic design last year, but experienced their first architectural studios online due to the February earthquakes. This is a serious problem in terms of the architectural studio experience and has had side effects and consequences similar to the COVID-19 pandemic in terms of the continuity of architectural education. First-grade students were in a face-to-face environment and suddenly found themselves in an online environment. Students have had to move away from the existing design environment in which they touch, see, transform concretely and watch what is transformed, and which additionally includes control and intervention. This, unfortunately, has brought along breaks, ruptures, adaptation difficulties and coldness similar to many problems we have experienced in the process of returning to face-to-face education after the pandemic. Moreover, the fact that the project group consists of first-grade students who have just started their architectural education has made the situation even more complicated.

From architectural design studio and architectural education perspectives, although most of the publications and shared experiences produced during and after the pandemic welcome online education as a new pedagogical formation, the publications and experiences that convey the problems encountered in the design studio after the transition to face-to-face education after the pandemic are limited. The advantages, disadvantages, limitations and opportunities of online education have been examined by many studies. For example, Yorgancıoğlu (2020) states the elimination of the physical studio environment as the main change in distance education due to the pandemic, underlining that the tools previously used as presentation and simulation tools have turned into pedagogical tools under the 'new normal' conditions, and that the state of isolation makes it difficult to provide the necessary discipline and concentration in the direct learning process. For example, Baloğlu and Sezgin (2021) indicate that critiques, juries and individual work rituals in design studios are activities that make up time-space routines and that one of the main outputs of the loss of the physical design studio is the change in time-space routines. In contrast to these studies, Ozorhon and Lekesiz (2021), in their studies that focuses on the remote architectural design studio experience and exploring the problems and potentials of this experience, consider the ability to access all online resources from any place and time as an important development in terms of flexible learning. In the study, which explored the perceptions and possible barriers of design students towards online design education in a traditional face-to-face learning environment, Fleischmann (2020) determined that the most important advantage of online education is flexibility in terms of time, and the most important disadvantage is the lack of instant feedback and social interaction during the problem-solving process and group work. Fleischmann (2020) found that students prefer to ask questions directly in the studio, like to receive feedback from their educators and peers, like to see direct hands-on solutions, and feel that face-to-face interaction helps them learn. Dreamson (2020), on the other hand, proposes meta-connective pedagogy for online design education, stating that the workshop model for design studios is often romanticized; accordingly, through the meta-connective process, pedagogical values are not only translated into connectivity, but also reconstruct successive learning processes. In this new learning environment, hands-on design activities and design experiments are structurally reconceptualized through various connection types and environments and are considered in a new context (Dreamson, 2020).

While the above-mentioned studies or studies that deal with the subject in a similar route try to comprehend the pedagogical permeability

and ruptures between online education and architectural design education, studies analyzing the change of design tools and students' perceptual differences in online architectural design studios are also remarkable. For example, Özen Yavuz and Yıldırım (2012), in their study determining which design tool is used at which stage of the design process, found that students found traditional presentation techniques positive due to their high creativity value in the early stages of the design process, but found these techniques negative due to the inadequacy of performing more than one action. On the other hand, digital presentation techniques were found to be positive due to competencies such as changeability of these techniques, technical results and design process, and the creation of the design product quickly and easily (Özen Yavuz & Yıldırım, 2012). Ceylan et al. (2021), who examine the opinions of architecture students about design studios carried out with distance education during the pandemic process, are interesting in terms of revealing the perspectives of students in different classes of architectural education on online studios. Accordingly, while it was stated that first-grade students were more optimistic about online studios and fourth-grade students were more critical, it was also determined that online studios had benefits such as the use of alternative communication tools, the ability to watch recorded course content, and productivity under suddenly changing conditions, regardless of the studio level (Ceylan et al., 2021). The same study also revealed that first and second grade students were more positive than third and fourth grade students about making physical models (Ceylan et al., 2021). In summary, the opinions, potentials, problems and research results about the online design studio are diverse, and more in-depth research results can be revealed with a broader look at the widespread literature.

The project group that this article focuses on is a first-year architecture in terms of educational base, and they spent their first education period at school, which basically consists of basic design. First-grade students of the SCU Department of Architecture switched to online education before the formation of a sense of belonging to the school of architecture could be completed, and this resulted in the fact that a studio culture was not formed/established in these students. This group, who took the basic design course face-to-face in the first semester of their education, received online education in the second semester, and then returned to school in the third semester of their education, that is, in the 2nd grade. The process is critical for both returning to school, creating a sense of belonging, and engaging in the studio culture. As stated by Yorgancıoğlu (2020), distance education has affected the role of 3D modeling, which is the most important tool of studio-based learning, and there has been a transition from physical models to digital models. This was also the case during the pandemic process and was also the case during the distance education process due to the February earthquakes in 2023. The change of design tools and/or the transition from the physical model to the digital environment does not only mean a change in the educational interface, but also the deterioration of the relationality between hand-eye-mind while creating the design thinking of the architecture student. Similarly, Güven et al. (2020) indicate that the level differences in students' mastery of 3D modeling programs in the computer environment eliminate random design decisions that can be achieved with models and transform the decision-making process with models into design-oriented solid models.

The studio group, which is discussed in the context of this study, has experienced different design processes and environments throughout distance education. Considering the level of the studio group, the students acquired the habit of making hand drawings and models for a semester in the basic design and Expression Presentation Techniques 1 course in the first semester of architectural education**.** Considering the design techniques, this short awareness of architectural education, the transition to the online studio and the break from school quickly led 2/3 of the 30 students in the studio group to 3D modeling tools in the computer environment. Since their levels of mastery of computer programs were different, some of the group spent most of their time

learning modeling programs instead of solving design problems or doing design research, while the other part of the group, confident in their good knowledge of computer programs, used quick modeling methods that focused on the final product. The last 1/3 of the studio group either completed the period with hand drawing and physical modeling and never turned to computer modeling tools, or they transferred the design process, which they started with traditional methods at the beginning, to digital media as they developed their computer modeling skills over time. Such a process experienced by the studio group has caused concepts such as design productivity, design problem-solving skills and the habit of doing design research to be missed. To this end, the return to the model, a traditional design tool, has been the main concept of the studio group's third term.

3. Pedagogical Approach: A Return to the Integration of Section and Model

It should be noted that the main result of the article titled "Integration of Section and Model: Reflections from a Studio Practice" is that it directs the student to do more research, increases interaction in the studio, and reminds the basic design exercises (Tuztaşı & Koç, 2020). The pedagogical environment/approach, which is coded as 'from section-model to space', has led the architecture student to develop a certain design behavior through formal anxiety, while at the same time allowing the development of design strategies to ensure the tectonic integrity of the plan-section-facade relationship. Thus, this new learning environment increased the potential for experience and exploration and transformed the studio into a process-oriented environment. Since the main framework of the 'from section-model to space' approach consists of increasing the design knowledge from experience and activating the potential for discovery, the physical model, which directly provides the relationality between hand-eye-mind, was used as a design tool. The physical model is a kind of designing dough that we will call the section-model, and the main dynamic that shapes it is the phenomenon of unfinishedness and incompleteness. While the fictional function of 'section' stems from the fact that it is a design tool that ensures shaping an architectural production, the establishment of cross-sectional relations is the shortest way to analyze the three-dimensional formal composition, which appears as an unfinished mass assembly. Revealing the cross-sectional relations between structural-formal mechanisms and applying deformations and transformations on the mass constitute the learning process based on experience and discovery of creating an architectural relationship between the exposed components of the unfinished/incomplete physical model. Sensory-rational thoughts, abstract-concrete relations, and form-content definitions are other process stages that are shaped by the student's design skills and intuition.

The study by Özbaki et al. (2016), which was published before the pandemic and analyzed the relationship between the physical model and digital model and design productivity, revealed that factors such as topography and built environment are noticed at the beginning of the design process since there is a concrete object in front of the designer in the physical model environment; in addition, it was also determined that the designer started the design through different inputs in similar terrain and function features in the digital model environment. In other words, the physical model significantly changes and affects the design process and design productivity. Acar et al. (2021) indicate that the design process requires visualization, conceptualization, three-dimensional thinking, the ability to direct the design in the mind, and the ability to mentally represent and follow physical and mental activities. In this context, the variability in 'section-model' facilitates and enables this follow-up. In other words, since 'section-models' show how design thinking travels in the mind, the studio process in the fall semester of 2023-2024 aimed to ensure the adaptation of the Mim2001 Architectural Project III group to concepts such as closeness, design productivity, design problem-solving ability and the habit of doing design research, which they could not establish with the architectural studio in online education. For this purpose, the process

obtained from the previous section-model experience was introduced to the studio group and the outputs were shared. Unlike the previous experience, the process has been reduced to 2 stages and, in addition, precise definitions have been made regarding the location and function. Accordingly, the place of study was determined as Bankalar Street, which is the most congested texture of the city, and Park Streets, which opens to this artery, and the function was finalized as the Veterinary Clinic, Dental Clinic and Bank building in the first stage and the Music and Dance School in the second stage. Below, the process and result products are shared.

4. New Reflections from the Studio: Case Report

Architectural Project III studio group, which experimented with by updating its approach from 'from section-model to space', has realized a production below the expectations of the studio tutor in terms of creating a physical model. Dynamic relationships and the weakness of cross-sectional relations are common features of physical models. For this reason, all of the resulting products are complemented by compact mass organization. In all of the models, there is rigidity in the installation of the mass, and this is due to the separation of the slabs in the horizontal direction and the creation of height differences between the slabs in the vertical direction. In all of the models, especially the 'cross-sectional' relations were missed, overlooked, not sufficiently understood or internalized. As a result, the phenomenon of incompleteness, which should be in the mass composition, has been replaced by a tectonic integrity with clear boundaries. Design productivity and the habit of doing design research have been defeated by mass conformism, and the process has tended towards achieving a final product as soon as possible. Therefore, the ability to solve design problems has been reduced to spatial-functional searches. While the fact that the function has been given in advance may be effective to some extent, another factor may also be the tendency to model quickly, obtain a model quickly and go to the result gained during the distance education.

It seems that the main element that enabled the studio process was not the section-model experience, but rather the excitement of intervening in a cramped and distorted urban fabric in a problematic urban area. During the project process, 'from section-model to space' approach has turned into a starting point that has not been sufficiently internalized as one of the ways to increase mass dynamism in the city. What differentiates compact mass organizations from other existing structural solutions of the city is the formal organization's search for a coherent and holistic relationship between interior and exterior. However, the dynamism of the architectonic content has been lost in the fragment of spatial solutions, regardless of function. In the first and second stages of solving design problems consisting of Veterinary Clinic, Dental Clinic, Bank building or Music and Dance School, common design behaviors were exhibited. Accordingly, one of the common design behaviors is the establishment of equivalent surface relationships in the horizontal and vertical directions in the compact mass organization. This design behavior resulted in the complete closure of the facade and the stagnation of the architectonic order between interior and exterior (Figure 1). In the example presented in Figure 1, the section-model experience of Student 1 is presented. Faced with a new experience in face-to-face education, Student 1 tends mostly to study with digital mediums instead of physical models. Student 1's reluctance to make physical models and his desire to quickly switch to the digital model limited his design productivity, and the return to school remained only a change of his physical environment for Student 1.

Figure 1: *An example of the result products that emerge by establishing equivalent surface relationships in the section-model (Student 1).*

Another common design behavior is shaped by the effort and concern to deform the compact mass organization. For example, Student 2 tried to achieve a formal equilibrium by using different horizontal surfaces in different elevation planes in mass organization. There are three design behaviors in this that deform the compact mass. The first is the elevation of the main mass by detaching it from the ground, while the second is the formal and dimensional variability of the floor openings in the horizontal direction. The third is the shell that surrounds the formal organization in the interior. Although this shell looks like a sheath that was put on the mass later, this search of Student 2 is important in terms of showing her design productivity and enthusiasm to work on the model, unlike Student 1. Although there is a lot of completion in the model, after the distance education process, Student 2 has presented a profile that is more inclined to make the design process efficient and experiment instead of being result-oriented. On the other hand, although the mass, which functions as a bank building, offers rational relations in terms of spatial analysis, some impermeable surfaces between the interior layout and the shell surrounding the outer wall of the mass are challenging in terms of integration between interior and exterior. Another challenging element in terms of mass organization is the problem of size. This is due to the novice and the habit of doing little experimentation brought about by starting to work again with the model when returning to school after distance education (Figure 2).

Another example of an effort to deform the compact mass organization can be given from Student 3. Although Student 3 basically managed the project process with a rigid attitude similar to Student 1, Student 3 increased the mass dynamism through the functional variability in interior solutions in her project, which she analyzed as a Dental Clinic. The mass, which resembles a prism of rectangles divided into two, has eliminated the mass massifism by means of non-equivalent divisions. In the horizontal direction, floors at different elevations and in different formal arrangements are connected to each other by bridges and uninterrupted circulation areas.

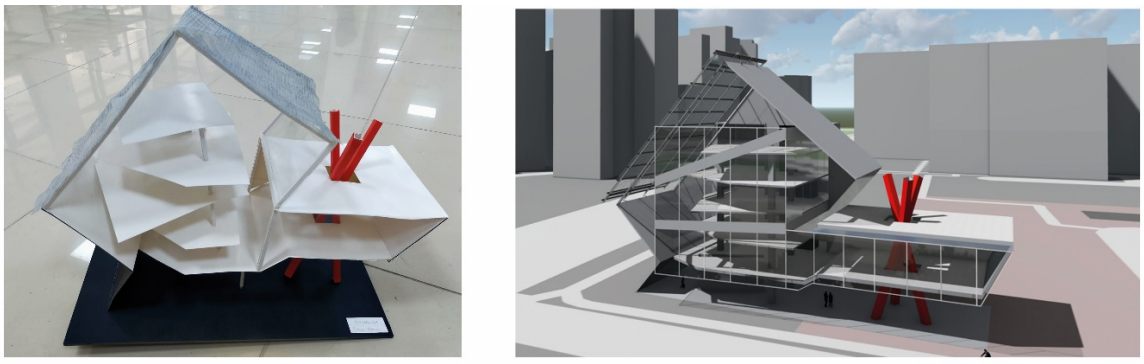

Figure 2: *An effort to deform the compact mass organization in the section-model (Student 2).*

Although the whole mass exhibits a rational inclusion, the absence of equivalent relations/elements in the architectonic order between the inner and outer has differentiated the mass. Student 3 continued the habit of producing quick solutions for the space, as in the distance education process, and on the other hand, she also looked for ways to improve her design productivity despite the exhaustion of the physical model. Instead of leaving the section-model experience to mass conformism, she tried to gain the habit of experimenting, but at the same time, she could not postpone the desire to reach the final product quickly. So much so that Student 3's performance in the second project process reduced the section-model experience to a physical model where massive mass relations are established. Student 3, in the School of Music and Dance project, realized the L-shaped mass by focusing on spatial analysis as in the first stage. The differences in the mass layout remained as formal definitions given to the functional solutions in the interior organization. Student 3 preferred to work on digital models instead of physical models. She paused her habit of reaching quick conclusions in the second stage, but instead of improving the design process or design thinking, she tended to increase her mastery of computer programs (Figure 3).

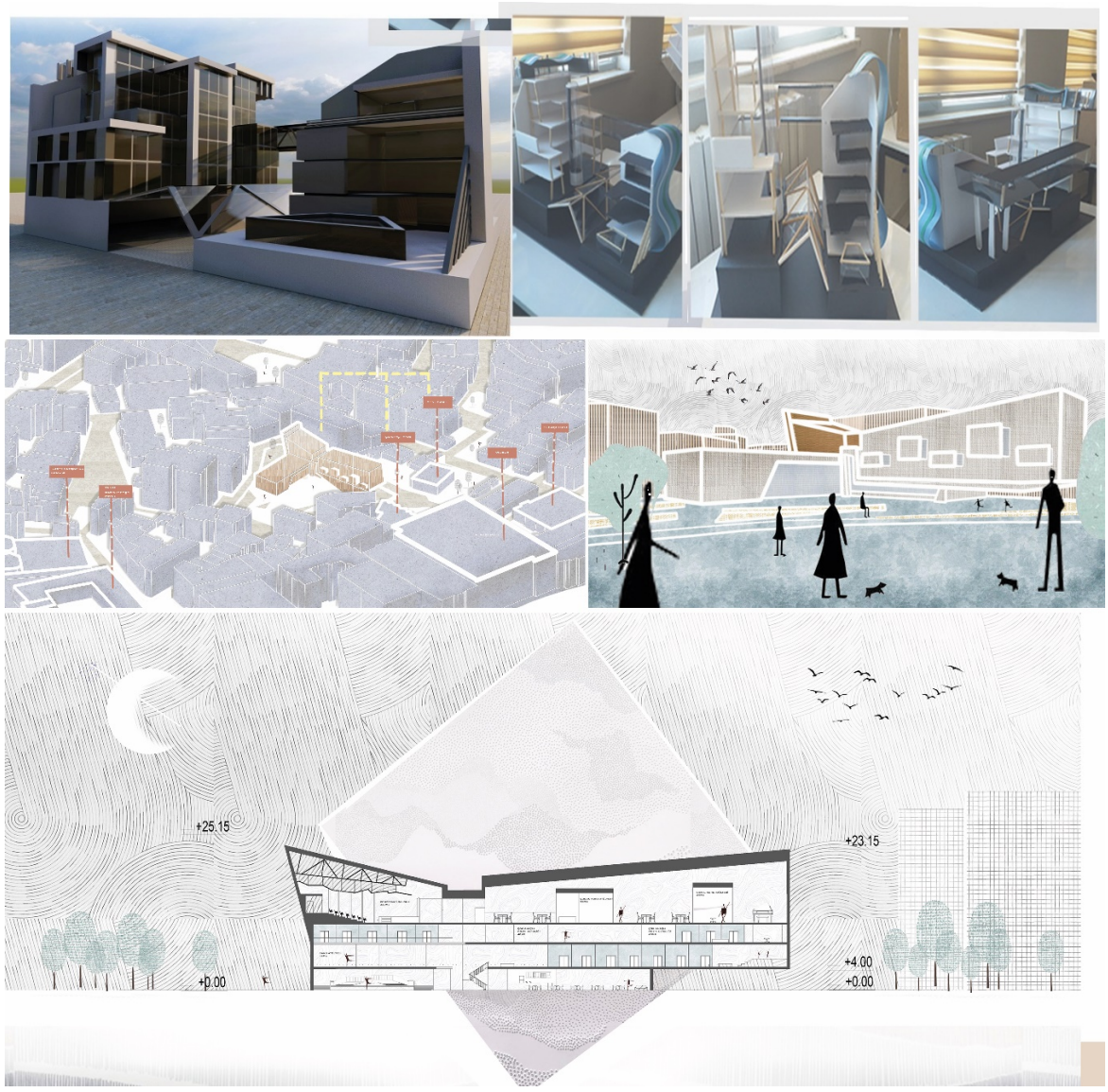

Figure 3: *An effort to deform the compact mass organization in the section-model (Student 3).*

The final collaborative design behavior is the combination/gluing/snapping together of discrete formal elements in a composition that seeks balance. Student 4 exhibited an attitude similar to the design habit she experienced in distance education in her first project as a Veterinary Clinic. The desire to create architectonic integrity and compositional balance by bringing together discrete formal elements constitutes an internal-individual design idea for Student 4. Student 4, who was looking for ways to bring 3 different masses together in the housing project she experienced in distance education, designed by using independent, different formal elements and their different position relationships in the mass organization in the section-model experience back to school. The section-model obtained by Student 4 is open to new experiments in its state of incompleteness. This makes Student 4's physical model the closest to the section-model experience. Independent formal assemblies connected by spaces, walls, eaves and bridges are also present in Student 4's School of Music and Dance project. Influences such as detaching the main mass body from the ground, formal elements with independent and different dimensional relationships, eaves and massive wall surfaces have become characteristic design elements that Student 4 acquired in her section-model experience. Accordingly, Student 4's School of Music and Dance project was shaped by an effect that came out of the section-model experience. Therefore, it is necessary to look for this in the individual characteristics of Student 4 and in components such as perception skills in the design process, openness to innovation, flexibility in design ability and inner sincerity (Figure 4).

Figure 4: *Compositions seeking balance of discrete formal elements in section-model (Student 4).*

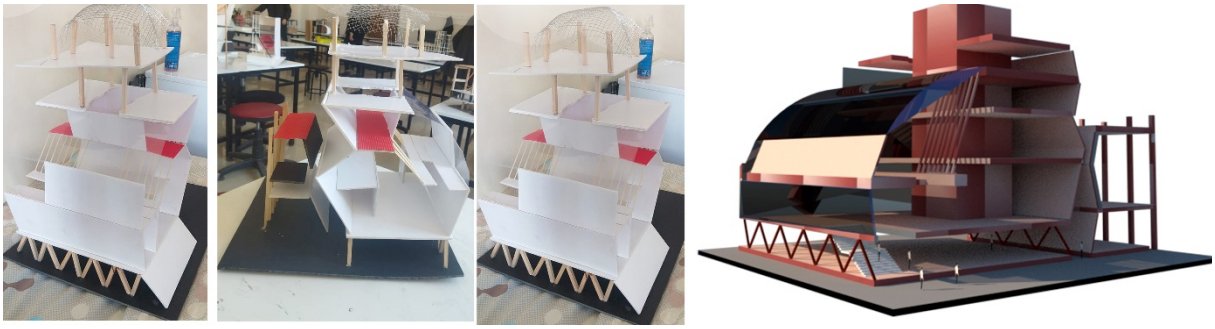

Figure 5: *An example of inconsistent experiments in section-model (Student 5).*

In addition to these three common design behaviors exemplified above, there have also been some inconsistent experiments in the studio process. For example, Student 5, although she used discrete formal elements in the mass composition, was weak in her search for balance and had a section-model experience that could not integrate the tectonic content. The cross-sectional relations and the incompleteness effect that emerged in the section-model have resulted in the unfinished fiction, poor spatial definitions and deformation in tectonic integrity as a reflection of the individual projecting process (Figure 5).

In addition, several other physical models have emerged in terms of being defined as section-model (Figure 6). However, these remained

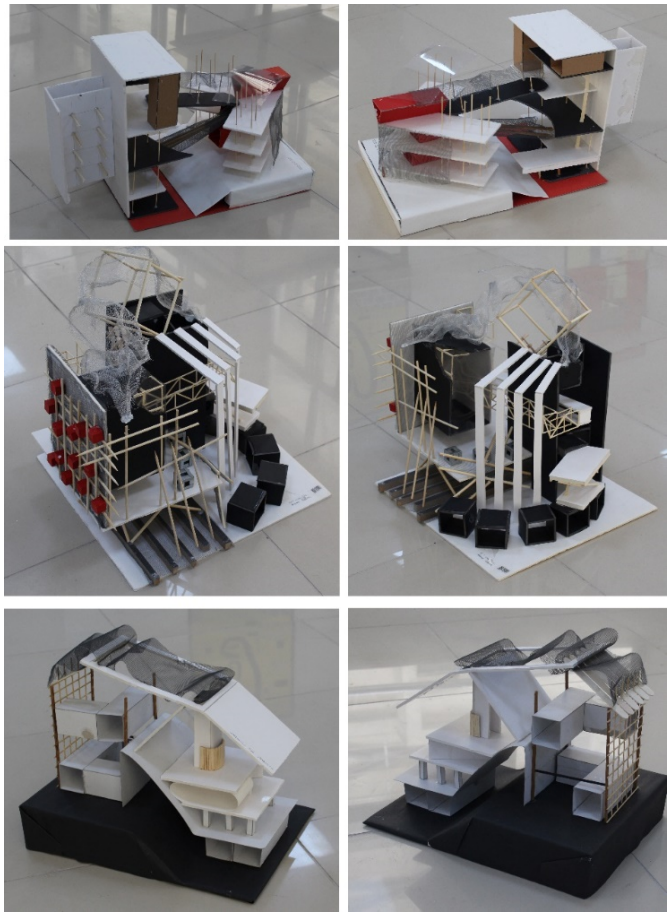

Figure 6: *Examples of architectonic integrity and spatial solution in the section-model.*

examples that did not achieve sufficient architectonic integrity and spatial resolution. The most important factor in this is the coldness and adaptation difficulties of physically leaving the studio when returning to school after distance education. The most important reason for the lack of experimentation and the lack of development of the section-model is the reluctance to work with the physical model.

5. Discussion and Conclusion

The distance education and face-to-face education process are examined from many perspectives through architectural design studios, and experiences gained in the process continue to be shared. In most of the studies, students' evaluations have been revealed through questionnaires. In this study, an evaluation of the process has been made through the studio tutor's follow-up of the process, observations and dialogue with the students. In other words, instead of the subjective expressions of the students, how the students coped with the studio process after the transition to face-to-face education was evaluated. For this purpose, the way students work with the physical model and their approach to working with the model were observed by the students who moved away from the digital screen and returned to the plural and interactive environment of the architectural design studio. Three main outcomes of the process have emerged. First, the projects that were thought about with the model and more experiments were made on the model were shaped by stronger effects. On the other hand, projects that made few experiments without spending enough time on the model and were quickly transferred to digital programs resulted in weaker or monotonous orientations. However, the most important and final result of the process is individual approaches to the architectural design process, whether in face-to-face education or in distance education. The high level of individual awareness can be attributed to the opportunities that the studio environment brings face-to-face, the cooperation with the tutor, and the opportunities for discussion among the students in the experimental methodology. On the other hand, in terms of this research, a retrospective comparison setup by re-experiencing the third-dimensional transfers of studio practice developed with cross-sectional models in future studios will be interesting in terms of its results. Another parameter is that the mental findings accumulated by the results of the transition to the studio after the online education cycle are updated and handled in a more comprehensive studio practice, and even these inquiries are experienced in the upper semesters when spatial reinforcements and structural solutions are further reinforced. Accordingly, it is also a practice of how far the model-based perception of the cross-sectional conceptions of this result is taken or comprehended. Because the third dimensional understanding acquired in the basic design studio course has commonalities in terms of the design practice cycle in the transition from section-model to space understanding. However, it cannot be ignored that the student cannot transfer the knowledge-based formulations that feed the tectonic content that he will take in the building and building materials course in the upper grades to the design result in the second year. Consequently, this transfer has examined the variability of design intuitions of a group of students who took a break from face-to-face education with online education. In addition to the third dimensional understanding of the design results section-models, the students also discussed the level or continuity of their infrastructure in the basic design course. The problematic area of the experimental practice, which aims to strengthen the relationship between spatial and tectonic context in the architectural studio course, for the student group is the relations between digital presentation techniques and models.

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Book Review

From Tradition to Cittaslow TARAKLI

Nevnihal Erdoğan, Hikmet Temel Akarsu
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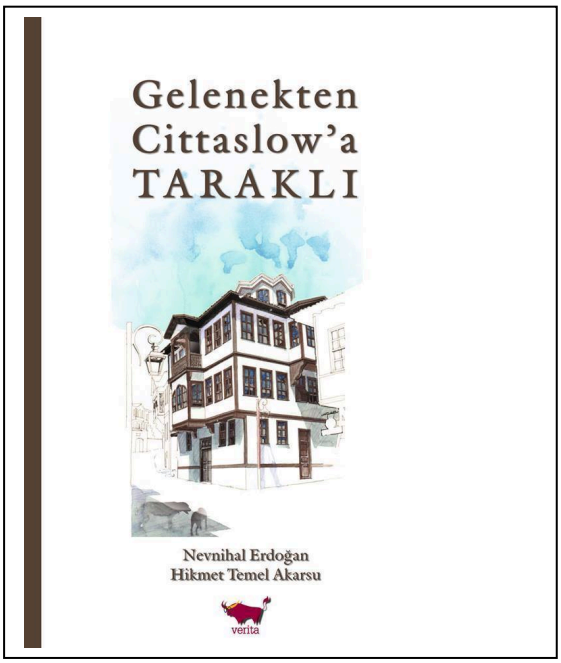

From Tradition to Cittaslow TARAKLI, (Gelenekten Cittaslow'a TARAKLI) (2018)
N. Erdoğan, H.T. Akarsu
İstanbul,
Verita Publications
199 pages

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Explaining the role and importance of space in today's people's search for happiness in a different and sincere way than the usual academic language, "From Tradition to Cittaslow Taraklı" is a book prepared by Nevnihal Erdoğan (architect, academician) and Hikmet Temel Akarsu (architect, writer) and published by Verita Publications in 2018. Although the book stands out as a kind of monograph of the Taraklı district; it also has the qualifications of being an academic textbook, a tourism guide and an inventory work within the scope of general culture.

The book consists of 15 chapters in which the authors' explanations about their approach and goals about the subject are emphasized, information about Taraklı district is given, the concept of Cittaslow is explained, field studies conducted under the supervision of Prof. Dr. Nevnihal Erdoğan are presented, the interview of Şahin Akı (Taraklı Municipality Deputy

Director of Planning and Urbanization) and the opinions of the municipality's public relations unit staff are considered:

1. Today's People are in Search
2. Why Taraklı?
3. The Fate of Taraklı
4. Taraklı's Fortune is Turning
5. A Brand-New Vision
6. What is Cittaslow?
7. The First Thing That Comes to Mind When it Comes to Cultural Artifacts and Historical Values
8. Taraklı is decomposing
9. And The Investor is in Taraklı
10. Taraklı: Exclusive Destination
11. Is Everything Perfect?
12. Conclusion & What Follows
13. Taraklı with its Architectural Features
14. Şahin Akı Interview
15. Opinions of Taraklı Municipality Public Relations Unit

Taraklı is a settlement which was built in accordance with the traditional Turkish house type dating back to the 16th century -but mostly consisting of buildings from the 18th and 19th centuries- and Muslims and non-Muslims have lived together. It consists of four neighborhoods, containing examples of civil architecture that have been declared and protected besides its natural beauties which were also mentioned by Evliya Çelebi described as a "cute town" by mentioning its mountains, forests and streams. The settlement, which constitutes a strategic point on the army's campaign routes, was affiliated with the Izmit Sanjak during the Ottoman Period, and became a district of Kocaeli until 1954 during the Republican Period. Taraklı, which was also visited by Mustafa Kemal Atatürk in 1928, remained within the borders of Sakarya province (that was established in 1954) and became a district of Sakarya in 1988. As a result of internal migration due to its location which is outside of the main transportation artery and its proximity to major cities such as Istanbul and Ankara, especially the young population of the district has decreased, its economic activity has weakened; but on the other hand, it has been left alone with its natural beauties. Thus, the district has begun to be an answer to people's search for natural -or in other words, "unspoiled"- spaces which are the most preferred destination features in the 2000's. It was even a candidate for the European Destinations of Distinction (EDEN) project and received an award in 2013 on the theme of "Accessible Tourism". Standing out with nature tourism with its plateaus and vegetation; health tourism with its healing water and hot springs; and festivals and local events that include organic food production and catering, Taraklı attracts attention especially from surrounding provinces such as Istanbul, Izmit, Bursa, Eskişehir and Ankara.

It is known that people's interest in recreation areas, undiscovered places and natural environments where they can breathe has increased nowadays as a result of their need to take a break from their busy lifestyle and have a holiday, even for a short time, such as weekend activities. However, on the other hand, it is an issue that requires some precautions to keep the destinations that stand out with their natural beauties and rich cultural histories intact. The concept of "Cittaslow", in another words "Slow City" becomes a solution approach at this point which has come to the fore with its targets for the protection of architectural heritage, local cultural characteristics, authentic activities and productions, and various technical and municipal measures and practices such as air-water-soil quality and waste management.

The authors considering the monotonous and fast-paced lifestyle as a threat to human happiness, also touch upon the problems of today's living spaces and base the book's starting point on human psychology; they aim to question the "correct" perception and use of spaces in people's search for happiness, and adopt an understanding that embraces traditional architectural values with a humanist approach. This approach, which reveals the claim and success of the book, conquers the reader with its writing language and content. The authors who bring together the concepts of tradition and Cittaslow in the example of Taraklı; created awareness through themes such

as new life models, happy life, aesthetics, calmness and alternative thinking in small settlements. The Cittaslow approach, which has been accepted by the innovative and forward-thinking local government of Taraklı district, has added a permanent identity value to the district as a model of development and improvement. Stating that being included in Cittaslow cities is a right step in this regard, the authors emphasize that this initiative offers a new perspective to Cittaslow studies as a good conservation method, will encourage similar settlements, and may be a suitable choice in some settlements based on tradition.

Taraklı district which became a member of the International Cittaslow Network in 2011, has developed and changed with creative ideas adhering to its traditions, with the cooperation of the local government and the people, and thus has inspired other districts of similar scale. At this point, the authors argue that these transformations are not easy to accomplish; they state that it is a process that will take place as a result of careful consideration of the reason, method and result, as well as the right effort. They associate the success of Taraklı, which they see as an exemplary model of development and improvement with the awareness of users and the proper use of public resources. Thus, with the right investments, the traditional texture and natural wealth of Taraklı are intact; unlike big cities, cultural and architectural heritage is protected without a sociological collapse and rent fight, as the authors mentioned.

Stating that the awareness of the protection of architectural heritage in Taraklı dates back to the periods before the membership of Cittaslow, the authors revealed that the district was handled by academicians of ITU in 1975, cultural assets started to be registered in 1985, the zoning plan for conservation came into force in 1992 and the work in the district continued by establishing relations with the Ministry of Culture in 2005. In line with these developments, restoration projects were prepared with the renovation workshops established in Taraklı, some buildings were put into service as boutique hotels, the district's Çekül Foundation and City Union memberships were acquired and thus Taraklı was discovered by more people. Becoming a tourism center for various nature sports and local delicacies along with its natural beauties, Taraklı also gained interest within advertisements and movies by becoming popular in the cinema and television community as the authors stated. Besides being a certain place in tourism as a thermal center currently, paving the way for new investments in the district has been the factor that has increased the confidence of the public and emphasized the importance of the efforts made so far. It is revealed that pedestrianization works were carried out with the membership of Cittaslow, air quality was improved by eliminating noise and visual pollution, the restored shops were selectively rented to tradesmen, and initiatives related to the promotion of the district were prioritized; in other words, it is expressed that efforts for development continue.

In the book with nostalgic archive photographs of Taraklı district; it is seen that a total of twenty-seven registered buildings, including nineteen houses-mansions, four mosques, one primary school building, one military building, one bath and one inn, were examined in three neighborhoods with their locations including plan, section and appearance drawings and photographs within the scope of the academic studies under the direction of Prof. Nevnihal Erdoğan whom has studied for many years with her students and with illustrations of Z. Türkiz Özbursalı. These qualified architectural examples are important in terms of political, social and cultural analysis and are a valuable inventory study of Taraklı:

13. Taraklı with its Architectural Features
    13.1. Hacı Murat District
        13.1.1. Selahattin Kozcağız House
        13.1.2. Haci Murat Mosque
        13.1.3. Alaaddin Öncü House
        13.1.4. İsmail Hakkı Akay House
        13.1.5. Hacı Murat Primary School
        13.1.6. Meriç Özen House

13.2.Ulucami District
- 13.2.1. Reyhan Tepe House
- 13.2.2. Hanımeli Mansion
- 13.2.3. Hacı Rıfatlar Mansion
- 13.2.4. Rushdie
- 13.2.5. Kadılar Mansion
- 13.2.6. Çiçek Hanım Mansion
- 13.2.7. İzzet Erdoğmus House
- 13.2.8. Fatma İşsever House
- 13.2.9. Abdi İbrahim Mansion
- 13.2.10. Lantern House
- 13.2.11. Yunus Pasha Mosque
- 13.2.12. Çakırlar Mansion
- 13.2.13. Çakıroğlu Mansion
- 13.2.14. Hisar House
- 13.2.15. Hisar Mosque
- 13.2.16. Hacı Atıf Khan
- 13.2.17. Old Bath
- 13.2.18. Hamam Street Building no: 31

13.3.Yusuf Bey District
- 13.3.1. Sadık Özen House
- 13.3.2. Yusuf Bey Mosque
- 13.3.3. Bedia Özyıldız House

Revealing the importance of preserving architectural heritage and the unspoiled natural environment this book put forth the story of Taraklı, which has inspired many settlements, local governments and users. With the emphasis that built environments are not only an architectural formation, but also a cultural whole with their users and even local administrators, a stance is taken in the book against the phenomena of uniformization, monotony and rapid consumption, which are the outcomes of modern life. An awareness has been created which invites designers, architects, students and academicians to think within this point of view. It has been pointed out that it may well be an alternative to the impositions of standard function, design and form. The book, by filling a gap in the field, reveals the necessity of spreading the Cittaslow approach as a development and conservation model.

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