Bridging Traditional and Digital: Evolving Architectural Pedagogy in the Modern Era

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Abstract

This research aims to explore the comprehensive considerations necessary for the effective integration of digital technology into architectural cognition, with the goal of developing a robust framework for digital pedagogy. The study meticulously examines existing methodologies and techniques utilized in Digital Design Studios worldwide, comparing them with current practices in Pakistan. By analyzing design methodologies and tool integration in studios from three different countries, this research seeks to highlight both differences and similarities, thereby contributing to a thorough understanding of the prevailing educational frameworks. The examination of case studies from diverse geographical contexts serves as a catalyst for questioning and potentially refining existing pedagogical practices. In Pakistan, the reliance on pedagogical methods from several decades ago underscores a pressing need to modernize architectural education and align it with contemporary digital media advancements. Consequently, this investigation represents a critical step toward understanding an innovative architectural pedagogy intertwined with technological progress.

Keywords*: Transgender Education, Vocational Training, Gender Diversity, Social Inclusion, Transgender Rights*

Introduction

The impact of recent technological advancements on the field of architecture has been profound, sparking a shift in design processes and transforming the industry's landscape. Specifically, the use of digital tools such as digital simulation, virtual environments, and image architecture has become increasingly integral to contemporary architectural design. While some architects have wholeheartedly embraced these changes, others have been more hesitant, acknowledging the transformational potential of these tools while also grappling with their implications for the traditional aspects of architecture.

A central challenge in this evolving domain is forecasting the future trajectory of digital tools in architecture. While these advancements were once considered daunting, they are now reshaping the industry and raising questions about whether they overshadow the symbolic value of architecture. Despite the industry's embrace of these tools for creative design and execution, there remains a notable lag in integrating them into the criteria for becoming an architect. In architectural education, there has been a significant focus on incorporating digital technologies, albeit with a more limited scope compared to other scientific fields. Existing curriculums often concentrate on specific topics such as structural design and environmental systems, posing a challenge for developing a comprehensive computer-aided technology framework. The shift from traditional methods to innovative ones is particularly challenging for many institutions, which are still navigating this transition. Developing a curriculum that encompasses computer-aided design content is crucial for transitioning toward a digital design decision-making process. However, the discrepancy between educators' experience, which may be more limited to physical construction technologies than intellectual design processes, emphasizes the need for a fundamental shift in architectural education.

The debate about adopting new digital methods continues, with both institutions and candidates often hesitant to tackle the challenges of updating course content, acquiring new skills, and adapting to unfamiliar environments. This resistance may stem from both instructors and students, with the former finding it difficult to alter long-established teaching methods and the latter potentially struggling with the new, more complex approaches.
To address these challenges, the initial step is to implement a curricular system that facilitates the transition to digital technology. After achieving societal acceptance, the next phase involves educating instructors to master these new tools, ensuring a smooth, long-term transition to an information-based educational format. The curriculum commonly

incorporates two major approaches, either adding computer courses for those unfamiliar with the technology or integrating existing computer courses. These courses should strive to create a welcoming learning environment for all users, regardless of their prior experience with computers. As students may adapt to these changes more quickly than instructors, the dynamic discourse about the integration of digital tools into architectural education will continue to evolve, leaving room for future advancements in design approaches.

Literature Review

The Modern movement and technological advancements in the 1960s brought computer technology into architecture (Sara Soliman, Dina Taha, and Zeyad El Sayad, 2019). It began with the introduction of programming languages to develop layouts and plans in 1958 (Schieck, Ava Fatah, gen. 2008). Architectural layouts were drawn for the first time using algorithms in 1965 (Simkovic, Vladimir, 2015). All these examples are considered to be the preliminary points for the introduction of computer-aided design in architecture (Antonios, Vasiliki, 2018). A few years later, the rapid spread of technology and the use of new software, known as Computer-Aided Architectural Design (CAAD), permeated all educational systems worldwide, leaving insufficient time for the development of an inclusive and articulate transformation of CAAD (Antonios, Vasiliki, 2018).

Form generation has always played a crucial role in architectural productions, whether in academic settings or in field practice. This is why the process or design approach that integrates various aspects of the design, such as user requirements, form, function, aesthetics, structure, context, construction cost, etc., has consistently been a subject of debate regarding its legitimacy. However, the remarkable shift can be marked right after the introduction of computational design techniques, which are termed as ‘generative design’, ‘algorithm design’ or ‘parametric design, as it adds an innovative and revolutionizing affair to the overall process hence, shifting it from predictable patterns of ‘form-making’ to embracing the complexities of the project i.e. ‘form finding’ (Agakthidis, Asterios. 2015). Despite the criticism that such techniques, on one hand in field practice take away the original essence of the overall site context from the outcome and on the other hand in academia, are a threat to the traditional model of education i.e. physical models and drafting techniques, these techniques existed even before the computational tools took over.

Frei Otto and Fredrick Kiesler's works are examples of similar techniques from the early twentieth century. But does this imply that the critics of digital architecture should also

be criticizing these tools or design methods? To understand this narrative, one needs to first get clarity on whether the design process needs an already-designed method or whether it should rely on mere personal inspiration. There has always been support for both, in addition to another type of thinking that supports the emerging design technique through computational and fabrication tools. So, for a better understanding, one needs to dig out a bit more about the historical design philosophies that paved the way for architectural productions of their time (Agakthidis, Asterios, 2015). 'the design process driven by nature' gained prominence in the late nineteenth century, emerging as an answer to a similar question of its time. Blaming its earlier architectural design methods as non-correspondent to the zeitgeist, the avant-garde school of thought found its solution in natural elements and sciences. The book Kunstformen der Natur by the German biologist became the inspiration for major projects like the Paris Métro station entrances by Hector Guimard, Hendrik Petrus Berlage's Jellyfish chandelier, and many others in the Art Nouveau and Art Deco movements. The emergence of more projects inspired by nature continued from the 1920s to the 1960s and 1970s, from Frederick Kiesler's Endless House (1950), Eero Saarinen's TWA terminal (1962), and Steiner's Haus Duldeck (1916) to many recent examples like Santiago Calatrava's City of Arts and Sciences in Valencia (1998) or Achim Mengese's web-like Icd/ItkE Research Pavilion in Stuttgart (2012), all incorporating the intelligent mimicry of living organisms' processes rather than mere form or appearance.

The research paper Computational Thinking and the Architectural Curriculum (Guzden, Suheyla, and Sema) discusses the recent trends in architecture education and practice that have encouraged the use of computational tools and methods for solving complex design problems. New technologies improve the design process by gradually applying more advanced computing tools. However, the complex nature of these devices causes students to become lost in the skill development phase, and the entanglement of terminology in computer-aided design has led to limited spatial design quality. With the widespread use of digital media, the integration of digital tools with architecture education and discourse in design education is a common theme. Open-source parametric and algorithmic design tools are developing the architectural design process. However, some studies demonstrate that digital design and architecture courses that focus on the junior years of architecture design education are more effective in terms of student learning outcomes. We can use the initial experimentation with digital tools in the early stages of architecture training to outline new paths for the rest of the educational framework. For many decades,

design schools incorporated CAD into design studios and non-studio disciplines (Guzden, Suheyla, and Sema).

Some schools use digital technology in specialized courses to computerize drafting skills, while others incorporate calculations for studio design. This research (Guzden, Suheyla, and Sema) identifies the four levels of digital media interaction for design courses: general computer usage, application involvement in digital media, design computation, and advanced exploration of design theory and ways. The essay by Duarte, Celani, and Pupo (G. Celani, R. Pupo, and J. Duarte, 2009) compares the strategies of two universities in transforming the architectural landscape and explores alternative methods for incorporating digital tools into design education. Citing two examples from Duarte, he proposes the isolated studio model with an updated computer curriculum against the traditional bottom-up approach. However, it remains unclear how to effectively integrate cutting-edge technology into the basic structures of curriculum transformation. Ultimately, even after mastering the fundamentals of the conventional curriculum, there persists a debate about whether students possess the necessary skills to develop strategies for integrating sophisticated digital devices. However, more and more, as these technological advances continue to make progress, we find that students have difficulty understanding the language around them (Celani G. 2012).

This discussion leads us to conclude that we need to manoeuvre this paradigm shift in architectural design. The development of new design methodologies includes algorithmic design (Celani G., 2012), performative design, and parametric design. The majority of these techniques use concepts drawn from the field of natural sciences (such as mathematics, physics, or biology) as the basis for developing an architectural methodology. Although the question of whether these tools are capable of grounding a new architecture in and of itself remains open (Kara, Dr. Levent, 2015), it is important to note that they introduce new concepts to architectural thinking, such as mass customisation and emergent form (Oxman, Rivka, 2008).

The digital transition is a worldwide phenomenon. It's transforming the way we work, communicate, and build and maintain relationships. It is transforming every aspect of our existence. A digitally transforming culture enables collaboration and creativity. As a result, they have the potential to significantly boost productivity and effectiveness. The demand for a framework to integrate technology tools with architectural curricula has grown as the growth of computer applications in the architectural profession has accelerated. It also

explores the significance of architectural education in shaping our built environment and its evolution over time, necessitating the advancement and development of architectural design studies.

Digitalization is about reinventing how you integrate humans, information, and systems in a digital environment to generate value for your consumers and preserve competitiveness. We are well aware that architecture, being one of the oldest professions, is concerned with the creation of a planned environment. As a result, design is one of the most important aspects of architectural education. We are rapidly approaching a time when digital technology and media have completely engulfed us. Among other uses, image architecture, digital simulation, and virtual scenes have increasingly become progressive architectural design terms. There is a pressing need for architectural education to adapt to these changes. They significantly influence various facets of our lives, including home, leisure, and work.

Digital Studio Platform in Designing Schools

Digital Design in Architecture is one of the topics that has been pushing the limits of architecture for almost a decade now. Architecture schools such as AA, Bartlett, SCI-arc, Columbia University, or Pratt Institute are driving the contemporary discourse in this field. Their research is approaching the subject in innovative and hypothetical ways, while also taking into account the structural network and architectural community. Consequently, universities in many other countries are following the trend. One of the significant implications of digital design is that it not only develops unique conventional materials, but also generates a multitude of innovative building ideas (Oxman, Rivka, 2008). We propose this design structure, along with its connections to current hypotheses, models, innovations, and methods used in computerised configuration investigation and digital praxis, as a model for design education. Any new system for teaching methods must adapt to situations where digital concepts integrate as a fresh collection of data, bridging the gap between digital architectural expertise and digital design proficiency. Any exhaustive hypothesis of digital architecture must begin to recognize the connections between theory and tool usage. Architectural design, like many other science subjects, makes extensive use of information or digital technology.

Intelligent computing is always emerging to improve the learning capacities as well as the performance of designers and architects in the field. In many situations, these technologies increase the quality of the design stage as well as the design outcomes. Architectural

education is diverse in character and frequently includes extensive practical experience. As a result, there is a need to improve educational quality in terms of learning, instructing, and practicing. People who practice this profession must be self-assured, gregarious, and naturally cultured, as well as forward-thinking to provide solutions to the public's design demands. The academic institution serves as the benchmark for developing these above-mentioned talents in trainee architects, and the effective introduction of technology to these students determines their growth in confidence and pedagogical expertise. Preparing architecture students for the difficulties of the 21st century is particularly difficult, given that professional associations, sceptics, and instructors have asserted in recent years that there is a "disassociation between the two different worlds of architecture education and practice." (Antonios, Vasiliki, 2018) Moreover, there's a claim that architecture schools generate graduates who don't grasp the realities of architectural practice, making them challenging to instruct. There is a need to modify the current architecture degree curricula, or at least reevaluate them, to more accurately reflect our evolving cultural landscape and highlight the glaring disparity in architectural education that limits both knowledge and performance.

Design education could be enhanced by providing specific methods for developing a sense of how to use pedagogical digital resources, encompassing not only technical skills such as programming or operating equipment, but also the ability to design digitally. Institutions should equip students with a solid understanding of fundamental policies, structures, and ideologies to enhance their practical skills in the future (Muhammad, 2017). Although students have been using computer-aided architecture design (CAAD) in architectural education for quite some time, it remains an unofficial tool. The education of architecture in Pakistan's universities has several issues, making it difficult to compete well with colleges and schools around the world. Digital innovations known as educational technologies store and retrieve information, fostering a constructive interplay between modernization and human values (Schieck, Ava Fatah, 2008). Educational institutions in Pakistan still do not use CAAD as an official digital resource due to various limitations such as students' financial circumstances, the unpredictability of electricity supply, mechanical failures, and device storage collapses. As architecture has expanded beyond two-dimensional drawing to cover three and four dimensions, architecture students' understanding and usage of CAAD in teaching and learning are important.

Digital integration in Turkey

During one of the undergraduate years, they practiced in a digital design studio during one of the years of the undergraduate program. We divide the digital design studio into two sections: theory-based and lab-based. This is intended to help students understand how theory and computational resources can work together to produce a better design. We encourage students to incorporate these procedures into the upcoming stages of their architectural projects. By understanding these frameworks as geometric elements, students actively engage with framework-based design principles. In the first semester, students explore various software, including Rhino, and participate in lectures and discussion sessions on digital design. Later, in their studios, they practiced the digital theory of architecture. The studios process the complete design project in a way that comprehensively utilizes both theoretical and practical knowledge on the topic of digital theory. The learning factor depends on both eye-hand coordination and the use of this technique in computerised approaches. The course also incorporates advanced 3D modelling techniques, with digital fabrication serving as its fundamental component. We use workshops equipped with 3D printers and CNC machines for fabrication. The use of technical software allows students to resolve tasks and coordinate the construction's aesthetic, technical, structural, financial, environmental, and social requirements.

Pakistan's technological integration

Students first encountered digital design theory in the fourth year of their five-year programme. This introduction focused on exploring "biomimicry," a concept that revolves around emulating natural processes and phenomena in design. The studio began with a research phase that tasked students with identifying intriguing phenomena or processes in the natural world. Once the students selected their areas of interest, we introduced a systematic approach that utilised "mind mapping". This technique aimed to refine the students' research and guide them towards the creation of a three-dimensional illustrative representation, referred to as a module, based on their chosen phenomenon. Following the completion of the module derivation process, the curriculum delved into the exploration of parametric modeling. The tools employed for this purpose included Grasshopper and Para Cloud Gem, both of which were novel and challenging to the students.

The acquisition of proficiency in these tools occurred within the studio setting, emphasising a hands-on learning approach. Students not only grappled with these new and unfamiliar tools, but also faced the pedagogical challenge of establishing a robust connection between their biomorphic research findings and the generation of solutions for architectural problems. The integration of parametric modelling into the curriculum marked a pivotal juncture, emphasising the synthesis of theoretical knowledge with practical application. The use of Grasshopper and Para Cloud Gem not only exposed students to contemporary digital design tools, but also provided them with a platform to manifest their biomimetic research in a tangible and innovative architectural context. This instructional approach reflects a comprehensive pedagogical strategy that encompasses diverse facets of the design process, fostering critical thinking, creativity, and the application of theoretical knowledge to real-world problem-solving.

The advancement of technology in architectural education in Pakistan is noteworthy.

The infusion of technology in architectural schools across the country is progressing at a very slow pace. As of now, there is no basic framework or structure for using information technology in architecture teaching. Some architecture schools have tried to adopt these contemporary changes in teaching; however, the majority of studio educators still find it inconvenient to infuse novel tools as a medium into the design process. The conventional education system is popular in the studio, and transformation is slow-paced. This study investigates Pakistan's pedagogical techniques and strategies by discussing a research-based educational approach that has been applied to teaching fourth-year students. We discuss this fourth-year design studio as an experiment, and compare its outcomes with those of studios around the world. The author has been teaching this methodology in the design studio for four consecutive years. The Department of Architecture introduced the digital design studio in 2013, making it the first department in the country to do so. However, its full potential remains unrealized, limited to a year-long fourth-year plan studio. The first, second, and third-year studios combine traditional drafting methods using Auto Cad with the introduction of advanced structural tools such as Rhino, Maya, and Revit in the fourth year. The majority of the design domain that is taught in studios is known as biomimicry, which is expressed as an imitation of living systems in nature. This study seeks to elucidate the concept of biomimicry, a concept that has emerged in the field of architecture in recent times, while also considering the design and nature of relationships in the context of architectural education. This study primarily aims to teach students a design technique through the application and

demonstration of biomimicry, highlighting the significant role of living animals in architectural design. Unfortunately, the transition from traditional methods to computer-aided design methods lacks clear definition, leaving some students unprepared to use technical software for design. Then again, students are introduced to both methods of architectural design education and can implement either or both methods when needed.

Research Objectives

The following are the research's objectives:

The aim is to examine and evaluate the present instructional techniques employed in global architectural studios, which incorporate technology and design tools.

We aim to contemplate the studio teaching techniques that can contribute to the advancement of tool and technology integration in Pakistani architecture education.

The aim is to suggest future directions in this domain. The new methodology for the studio framework's implementation in Pakistan will receive suggestions and recommendations.

Research Methodology

This study examines the integration of tools and technology in architecture education through a global analysis of studio teaching methodologies, followed by a reflection on the studio design methods employed by these institutes. We study the teaching methodologies from three architectural studios located in the United States of America, Turkey, and Pakistan. The thorough examination of literature and the studio's initiative aided in suggesting strategies for integrating tools and technology, particularly in countries such as Pakistan where the adoption of these changes is not well-received. We then compare these outcomes to develop an implementation strategy for revamping the architectural education framework that incorporates technology. This study will help provide some important insight into how educational institutes implement logical and methodological ways of teaching digital design. This research draws its insights from the design of practice-driven educational models and research-based studios. The Studio course outlines projects that adopt learning techniques and promote experimenting with digital philosophies with pedagogical methods suitable for the local context.

Discussion and Recommendations

Discussion

Almost all three studios rely on phenomena from the natural sciences for their theoretical or research aspects, thereby integrating science into architecture. Although integrating pure

science to evolve architectural design is a technical phenomenon in itself, It is only possible with the availability of these novel and technical tools. Another crucial observation is that teaching digital tools as supportive electives and courses doesn't significantly alter the overall integration of these tools in the design studio. The best learning and integration of tools take place in the studio while working directly on the solution to an architectural problem (Simkovic, Vladimar, 2015). Learning is much more advanced when they use the tools during the design process, as compared to taking electives or attending workshops to learn the tools only. The tasks in the different support courses will shine a general spotlight on the basics of drawing or modelling with software. These tools don't reach their maximum capacity before the students use them as instruments of reasoning and presentation for complex design problems they encounter in the architectural design studio (Simkovic, Vladimir, 2015). Therefore, it is pertinent to use tools as a medium for design. Over the last two decades, these digital tools have started to emerge in architectural education as key components of general curricula and design teaching (Al-Qawasmi, J. 2005). Design studios worldwide are increasingly utilizing digital tools. Simultaneously, the decision of when, where, and how to integrate these tools into the curricular framework plays a crucial role. Even as the profession shifts its process and production towards digital environments, primarily using CAM techniques to produce physical models, these tools still necessitate an internalized understanding of seeing, thinking, and creating space, which the digital environment alone cannot foster (Simkovic, Vladimar, 2015). Nearly all three studio frameworks use tools to solve a specific problem. We observe that the process stays consistent, with a primary focus on the process rather than the tools. Therefore, it is crucial to align the pedagogic framework with the dynamic design process. On the other hand, we should not let technology and tools dictate the product's design, but rather utilize them as a tool to create innovative and sustainable architecture. The primary methodology should incorporate a design course that is clearly divided into smaller, crucial stages such as research, creative development, implementation, and presentation. This approach not only establishes a structure for the framework but also guides the pedagogical process. Therefore, a sequence of challenges confront the contemporary studio framework, ranging from questions about the optimal time and method to introduce the right tools in the curriculum to issues surrounding the content of relevant teaching.

Currently, architects benefit from traditional soft skills such as perfectionism and sensitivity, but digital soft skills are unique in that they relate to the tools and procedures used in design

software. Digital soft skills, in the sense that they influence how students employ technical abilities, are comparable to conventional soft skills. They serve as a link between design and technical (hard) abilities, such as digital approaches. Different soft skills that could be part of the architectural course include communication skills, management of time, digital hygiene, and adaptability. We can classify most of the examples in the soft skills section as personality or character qualities. Since successful students may already exercise them, we typically think of soft skills as character qualities rather than teachable attributes. Even without formal teaching, the studio and lab should reinforce soft skills to establish appropriate habits. Instructors should be aware of and consistent in their own habits, modelling the behaviours they teach in their own activities. Soft skills and learning objects help students achieve the goal of not only functioning well with technologies, but also working collaboratively with others in technologically assisted ways. Students may use digital soft skills to assist them in understanding computer-aided design and, subsequently, using technological expertise effectively and with refinement, as well as adapting to a quickly changing digital context. Understanding, talents, perspectives, and practices influence not just the design process, but also the goals and outcomes. Soft skills and learning objectives, which extend beyond academic considerations, influence design. Designers of the 21st century need to understand and learn digital design modes, and architectural education should now prioritize integrating digital technology courses into their curriculum. This will enable students to acquire and apply all the soft skills used in the field of architecture to create digitally complex and contemporary architecture. This research also underscores the need for today's architectural education to develop a framework that enhances student learning goals and teaching facilities.

It also helps to highlight the influence of tools and technology on design studio learning. As architects, we operate in a period where traditional and modern methods coexist in architectural design studios. These new technologies in design education create a challenging connection between the techniques and the intended outcomes, leading to uncertainty about the design concept. Archer (Kara, Dr. Levent, 2015) defines digital architectural design as a goal-directed problem-solving activity, a complex process that involves the creation of a cohesive structure or system from numerous united pieces, each defined by different theorists.

The increasing use of digital technology in the design process and final product has influenced architecture to satisfy specific practical, cultural, and aesthetic requirements. As a necessity in terms of aesthetics, the environment, and socioeconomics, digital technology has emerged as a moderating element between architectural theory and design theory. Some schools, however, have begun to reconsider the use of digital software as an analytical, creative, and constructive tool since 2014. Consequently, they incorporated software such as "Revit" and BIM into their curriculum as electives. In general, Pakistani architectural schools blend physical and digital approaches to provide students with the best of both worlds. As a result, most, if not all, architectural schools forbid students in their first two years from using CAAD technologies in design. Design training for first- and second-year studios emphasises the necessity of establishing manual graphic communication skills, drawing, and the practice of constructing physical models. On the other hand, most schools' current architectural design curriculum lacks synchronization and integration between computer courses and design projects.

Recommendations

We recommend initiating technology integration at a very early stage for architecture students. More technology, such as materials and methods, should be available to facilitate increased experimentation, which is always beneficial for the evolution of ideas in architectural projects. We recommend a multidisciplinary joint effort with stakeholder support to ensure the general acceptance of advanced practice in the built environment. We strongly recommend incorporating digital design theories into higher education curricula through specialized training workshops and events. Academic institutions should initiate the development of digital labs, the use of innovative materials, and manufacturing procedures, as these initiatives have the potential to yield significant environmental benefits due to their sustainable nature. Pakistan should establish architecture schools or departments that focus on the digital design framework.

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